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Guidelines for weed control

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AGRICULTURAL RESEARCH SERVICE • U.S. DEPARTMENT OF AGRICULTURE • AGRICULTURE HANDBOOK NO. 44



USDA POLICY ON PEST CONTROL

It is the policy of the Department of Agriculture to practice and encourage the use of those means of practicable, effective pest control which result in maximal protection against pests, and the least potential hazard to man, his animals, wildlife, and the other components of the natural environment.

Nonchemical methods of pest control, biological or cultural, will be used and recommended whenever such methods are economically feasible and effective for the control or elimination of pests. When nonchemical control methods are not adequate, integrated control systems utilizing both chemical and non-chemical techniques will be used and recommended in the interest of maximum effectiveness and safety.

Where chemicals are required for pest control, patterns of use, methods of application and formulations which will most effectively limit the impact of the chemicals to the target organisms shall be used and recommended. In the use of these chemicals, the Department has a continuing concern for human health and well-being and for the protection of fish and wildlife, soil, air, and water from pesticide contamination.

In keeping with this concern, persistent pesticides will not be used in Department pest control programs when an equally safe and effective nonresidual method of control is judged to be feasible. When persistent pesticides are essential to combat pests, they will be used in minimal effective amounts, and applied only to the infested area at minimal effective frequencies.

In carrying out its responsibilities, the Department will continue to:

- Conduct and support cooperative research to find new, effective biological, cultural, and integrated pest control materials and methods;
- Seek effective, specific, nonpersistent pesticides and methods of application that provide maximal benefits and are least hazardous to man and his environment;
- Cooperate with other public and private organizations and industry in the development and evaluation of pest control materials and methods, assessment of benefits and potential hazards in control operations, monitoring for pesticide residues, and dissemination of pesticide safety information.

All users of pesticides are strongly urged to heed label directions and exercise constant care in pesticide application, storage, and disposal for the protection of people, animals, and our total environment.

The Department commends this policy to all who are concerned with pest control.


Secretary of Agriculture

PREFACE

This handbook provides guidelines for the use of chemicals that may be used for the control of weeds. It is not intended to provide recommendations to be followed directly by the individual users of chemicals. It is provided as an informational source for those who are responsible for developing specific use recommendations for pest control chemicals.

Omission or inclusion of a chemical does not imply judgment as to its efficacy. Inclusion of a chemical is based partly on the extent to which it is actually used. A chemical may have been omitted because, although registered for a given purpose, it is mentioned only infrequently or not at all in published control recommendations.

The chemicals included in this handbook were registered by the Federal Environmental Protection Agency (EPA) as of the issue date on each page. These chemicals are currently being rather widely and effectively used in accordance with the published control recommendations.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended by the Federal Environmental Pesticide Control Act (FEPCA) requires that all pesticide products (formulations) be registered by EPA before entry into intrastate or interstate commerce. In addition, the individual States may have special registration and use requirements for pesticides. FEPCA provides for civil or criminal penalties for the misuse of pesticides. Use of nonregistered pesticides or use in violation of the directions on the label are punishable.

This handbook has been prepared in a loose-leaf form so that it may be periodically updated as needed. Subscribers to this handbook will receive the updated pages as they are printed.

This handbook supersedes Agricultural Handbook 332, "Suggested Guide for Weed Control, 1968."



Washington, D.C.

August 1973

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SUGGESTED GUIDE FOR WEED CONTROL

Prepared by Agricultural Research Service

BASIC PRINCIPLES AND METHODS OF WEED CONTROL

[The technical information in this publication was compiled and reviewed by L. L. Danielson, W. B. Ennis, Jr., P. A. Frank, W. A. Gentner, E. W. Hauser, D. L. Klingman, R. J. Smith, Jr. and weed science personnel of the Agricultural Research Service. Helpful suggestions were made by reviewers in the Extension Service, Environmental Protection Agency, and the Department of Interior.]

Annual losses due to weeds and the expense of control measures cost the U.S. farmer \$5 billion. In response to these costs, mechanization of crop production is advancing rapidly.

Highly efficient weed control methods are a necessity in the mechanization of production. Because of this necessity weed scientists are developing new control methods at a rapid pace. These new developments include herbicide treatments, cultural practices, biological methods, mechanical equipment, and many combinations of these. Methods used in a particular situation depend on the soil, the crop, and the weed problems involved.

Sound weed control practices are developed in coordinated fundamental and applied research programs. All phases of agricultural science and many related biological, chemical, mathematical, and physical sciences are involved. This research yields information on every aspect of the performance and effects of weed control methods. This includes assessment of effects on the environment in general and specifically on man, animals, and plants.

The principles, data, and methods presented in this handbook are based on information obtained in these comprehensive research programs.

LIFE HISTORIES OF WEEDS

[Source of Common Names: Report of the Subcommittee on Standardization of Common and Names of Weeds. Weeds Science 19 (4): 435-476. 1971.]

What is a weed? It is any plant growing where it is not wanted. It may be a wild plant, or it may be the result of crop seed left in the field from last season.

We should clearly distinguish the difference between wild plants and weeds. All wild plants are not weeds. Many do not compete with crops or ornamental plantings. They serve various functions in nature, such as reducing erosion, providing food and cover for wildlife, and furnishing nutrients and mulching in their decaying stages.

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Weeds, like other plants, are classified by growth cycle as annuals, biennials, and perennials. Algae and some other aquatic plants have shorter life cycles.

Annuals mature in one season and are nearly always propagated by seeds. Examples are pigweed, crabgrass, and common ragweed. A variation of the true annual is the winter annual that germinates in the fall and matures seed the next season. Examples are cheat, pennycress, shepherdspurse, and wild barley.

Weed species have survived over many centuries because of their ability to survive many kinds of climatic extremes. They survive because of seed tolerance to extremes of low and high temperatures, wet and dry conditions, variations in oxygen supply, and many combinations of these and other factors.

Only a small percentage of the seeds of most weed species germinate in any single year. The remaining seeds stay dormant and germinate in succeeding years. The seed supply in the soil is replenished periodically in the years of favorable growing conditions.

Survival of weed species is aided by the production of large numbers of seeds by each plant. For example, a pigweed plant may produce 100,000 seeds, a lambsquarters plant 70,000 seeds, a curly dock plant 30,000 seeds, a barnyard-grass plant 7,000 seeds, and a purslane plant 50,000 seeds. Survival of only a few weed plants per acre can therefore maintain continuing large reservoirs of weed seeds.

Weed seeds buried deeply in the soil can survive for many years. One of the early weed scientists found that seeds of redroot pigweed, prostrate pigweed, common ragweed, black mustard, Virginia pepperweed, evening primrose, broad-leaf plantain, purslane, and curly dock germinated after being buried in soil for 40 years. Some survived for more than 70 years.

Availability of oxygen and light appears to influence germination of weed seeds. This helps to explain the new populations of weeds that emerge after each cultivation. Cultivation brings dormant weed seeds to the surface layer of soil where oxygen and light are available and higher temperatures prevail.

Biennials require two growing seasons to complete the reproduction cycle and are propagated by seeds only. Common examples are burdock, wild carrot, and mullein. They often can be controlled by cultivation or timely mowing.

Perennials live more than 2 years. Common examples are Canada thistle, cat-tail, field bindweed, johnsongrass, and nutsedges. Many perennials in addition to seeds have several methods of reproduction. These include bulbs, tubers, corms, lateral roots, rhizomes, and stolons. Most of these organs have buds and store food for overwintering and reproduction. Several provide means of vegetative spread. Many perennial weeds are difficult to control and require intensive and persistent effort. Unlike most annual plants killing the top growth of a perennial once does not usually prevent it from surviving and producing a new top growth from food in the storage or reproductive organs. To prevent this vegetative reproduction, the supply of stored food must be greatly depleted by repeatedly destroying the top growth, roots, and reproductive organs or greatly altering the physiological processes

with herbicides. Many aquatic weeds on the other hand may reproduce vegetatively from leaf fragments, stem or root parts, as well as seeds.

PLANT COMPETITION

Competition of desirable plants with undersirable plants frequently provides effective and economical weed control. Careful selection of adapted and desirable species or varieties and maintenance of optimum soil fertility and cultural conditions for their maximum growth are important. Mowing, pasturing with livestock, spraying with selective herbicides, liming, fertilizing, or other means of altering the environment to favor the desired species over weeds may be necessary for the most satisfactory results. Usually the desired competitive crop must be planted.

In the aquatic situation, competition is affected by transparency of the water, water currents, wave action, frequency and elevation of dewatering, and chemical factors such as water hardness, pH, and availability of plant nutrients.

Occasionally a mixture of desirable and undesirable vegetation already established on native ranges, banks, of irrigation ditches, canals, streams, lakes, and other impoundments, fence rows, or other noncultivated areas can be favorably altered by repeated applications of selective herbicides. Under such treatment the resistant desirable species become dominant and the susceptible undesirable species are gradually eliminated. The elimination of deep-rooted perennial weeds or other aggressive species often necessitates the use of drastic and frequently expensive chemical or mechanical methods. Thereafter, desirable species can be planted and suitable conditions provided for their effective competition with surviving or reinvading weeds.

METHODS OF CONTROL

Hand and Mechanical Methods

Numerous effective herbicides and improved methods of application have replaced many less effective hand and mechanical methods of weed control. However, hand and mechanical methods are still necessary or advantageous in many situations. Hand weeding of flowerbeds, small vegetable gardens, and other small-area plantings sensitive to herbicides is often the safest and most satisfactory method. Mulches also aid in weed control. Improvements in tools used for cultivating, mowing, burning, and ditch cleaning and in other machinery needed for vegetation control have coincided with improvements in chemical methods. Judicious use of such equipment in seedbed preparation, cultivation of crops, and mowing in noncultivated areas may cause weed seeds to germinate, destroys successive crops of weeds, and prevents weeds from producing mature seeds. Even the most effective chemical methods frequently must be combined with hand or mechanical weeding to remove surviving weeds and to prevent future spread by seed or other plant parts.

Water level fluctuations, mechanical weed cutters, harvesters, and hydraulic devices, also have specific application to aquatic weed situations where physical barriers and topographical features are compatible or where chemicals cannot be used.

Flame

Flame is used effectively for weed control in some situations. Several types of burners are available. Those used for nonselective control of weeds as on ditchbanks produce a relatively large, varying flame pattern. Those used for selective control of weeds as in cotton and corn produce a relatively small constant flame pattern that can be confined to definite areas in or between the rows. Some specialized burners are designed to trap and retain the generated heat momentarily in the weed area.

Fuels most commonly used are propane, butane, and mixtures of these two petroleum gases. Either a vaporizer or self-energizing design of the burner usually increases the efficiency of the combustion. Fuel oil, kerosene, and other petroleum liquids are also used.

Herbicides

Since 1950 thousands of chemicals have been evaluated for effectiveness as herbicides and more than 100 of these have been recommended for controlling one or more weeds. The effectiveness of herbicides on susceptible species is affected by stage of growth, soil organic matter and pH, fertility and texture; rainfall and irrigation; water pH and chemical content; temperature of air and water; light intensity; and other soil, water, and climatic factors. Crop and weed plants vary widely in their responses to different herbicides.

Safe and effective herbicides are available for controlling many weeds growing in various environments, including cropland, rangeland, gardens, lawns, ditchbands and other noncrop areas, in irrigation, drainage, navigable, potable and recreational waters. Because of the many factors and principles involved, and the dynamic nature of research on herbicides, information about chemical weed control is rapidly increasing and new recommendations are continually replacing old ones.

Biological Agents

Only limited attention has been given to controlling undesirable plants by using insects, plant disease organisms, and other natural enemies. Research is now underway to discover and develop effective and safe biological agents to control such weedy species as alligatorweed, waterhyacinth, submersed aquatic weeds, Scotch broom, halogeton, cactus, tansy ragwort, puncturevine, gorse, and St. Johnswort. One noticeably successful biological control agent in the Northwestern States is the beetle Chrysolina spp. This insect is native to Europe but was introduced from Australia to the United States to control St. Johnswort. Research on biological control of weeds is being increased.

IMPACT OF WEED CONTROL ON CROP PRODUCTION

Weed-control principles, methods, and practices have an important impact on all phases of crop production. New chemical, cultural, mechanical, biological, and combination methods of weed control affect crop choice; the variety to use; seedbed preparation; method of seeding; seeding rates; row spacing; plant spacing in the row; plant populations; fertilizer practices, including type, time of application, and placement; cultivation; irrigation practices; harvesting; seedcleaning operations; erosion control; fallow practices for weed control; disease- and insect-control practices; pasture renovation; pasture and range management; clearing new lands for crops or pasture; forest management; the utilization of farm water resources for irrigation and recreation; and the maintenance of drainage ditches, ditchbanks, irrigation canals, and farm roadsides; and management and harvest of fish and wild life resources in both aquatic and terrestrial situations. Equally important are the significant effects crop management and production practices have on the choice and effectiveness of weed-control methods.

PRECAUTIONS FOR SAFE USE OF HERBICIDES

All chemicals described in this handbook, especially when used in water or on raw agricultural crops as defined under Public Law 518, should be applied in accordance with the directions on the manufacturer's label, as registered under the Federal Insecticide, Fungicide, and Rodenticide Act. Specifications with respect to crop, amount of chemical, and time of application should be strictly observed.

Some herbicides may be irritating or potentially dangerous if not used properly and if recommended precautions are disregarded. Most Herbicides have a low acute oral toxicity, but a few are highly toxic to humans, livestock, wildlife, and some are toxic to fish. The relative degree of acute toxicity to warmblooded animals is given for most herbicides in the following section on CHEMICAL, PHYSICAL AND BIOLOGICAL PROPERTIES OF HERBICIDES. In that section the LD₅₀ ratings (lethal dosage that kills 50 percent of experimental animals) may be evaluated as to oral toxicities by reference to the following table.

<u>Class</u>	<u>Acute oral toxicity</u> <u>LD₅₀ mg. per kg.</u>
Highly toxic -----	50 and below ----
Moderately toxic ----	50-500 -----
Mildly toxic -----	500-5,000
Nontoxic -----	Above 5,000 -----

All LD₅₀ values are based on a single dose of material orally administered to animals, followed by observation of the treated animals for a definite period. However, these findings do not indicate the possible hazards that may arise from skin contact or inhalation of the substances. Likewise, these data do

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not accurately predict the toxicity of formulations of different composition.

Precautions for Humans

1. Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.
2. Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed.
3. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.
4. Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.
5. If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.
6. Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.
7. Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.

Precautions for Livestock

1. Prevent livestock from grazing in herbicide-treated areas for periods recommended on the label.
2. Prevent livestock from drinking herbicide contaminated water during the time after treatment prescribed on the label.

Precautions for Wildlife and Fish

1. Avoid spillage of herbicides or disposal of pesticide containers in or near streams, ponds, and lakes or in areas frequented by wildlife and

inhabited by fish.

2. Avoid spillage of pesticides, disposal of containers or cleaning of spray equipment in or near lakes, ponds, or streams.
3. Consult Federal or State game and fish departments for advice if a proposed herbicide application might endanger wildlife, fish, or their habitat.
4. Use those herbicides or formulations that pose the minimum hazard to fish and wildlife. See CONTROL OF AQUATIC WEEDS.

Precautions for Desirable Plants

1. Avoid spraying when and where drift of fine spray or volatilized fumes are likely to contact nearby sensitive crops or ornamental plants. Use spot treatment control of weeds in lawns if they are not too numerous.
2. Reduce drift hazards by using low drift formulations, amine or low-volatile esters of phenoxy herbicides, low spraying pressures, and large volumes of coarse sprays and by spraying when wind is low in velocity and blowing away from nearby sensitive plants. Do not spray when temperatures exceed 90° F.
3. Avoid applying a soil sterilant herbicide to the foliage or over the root zone of a tree, shrub, or other desirable plant where leaching the chemical into the soil may result in death or injury of the plant.
4. Avoid applying herbicides or cleaning out application equipment on sloping bare ground, pavement, or other areas where the herbicide may be carried by surface runoff to valuable plants or to aquatic sites.
5. Avoid using herbicide sprayers for other purposes on crop or ornamental plants.
6. No matter how well it has been cleaned, do not use a sprayer previously used for applying phenoxy herbicides to spray cotton, tomatoes, grapes, and many ornamentals highly sensitive to 2,4-D and other phenoxy or similar growth-regulator herbicides.
7. Do not store herbicides near seeds, bulbs, fertilizers, insecticides, fungicides, or other farm chemicals and supplies.
8. Observe care in the disposal of pesticide containers and avoid reuse.

PROPERTIES OF HERBICIDES

Descriptions of the chemical, physical, and biological properties of herbicides mentioned in this handbook are given below. The herbicides are designated by their common and chemical names. Their acute oral toxicity to warm-blooded animals is indicated by the LD₅₀ rating given in terms of milligrams of herbicide per kilogram of body weight of rats, except where other animals are specifically named. The basic chemical reference material used to calculate application rates is shown for each herbicide. The kinds of commercial formulations are given as a convenience in determining the kinds of application equipment needed in using the herbicides. Brief reference is made to certain important weeds controlled by each herbicide, some of the practical uses in crops, specialized methods of application, and specific toxic or persistence characteristics. Specialized, suggested uses of the herbicides in various crops and in noncrop weed situations are described in detail under the appropriate headings.

THE FEDERAL ENVIRONMENTAL PESTICIDE CONTROL ACT OF 1972

The Federal Environmental Pesticide Control Act (FEPCA) of 1972 became law on October 21, 1972, revising the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947.

Some sections of the new Act became effective immediately, while others have deadlines for later enforcement, pending the establishment of regulations and development of Federal standards to guide States in implementing the legislation. All of the provisions of the new Act must be in effect by October 1976.

Before registration may be granted for a pesticide product, the manufacturer is required to provide scientific evidence that the product, when used as directed, will (1) effectively control the pest(s) listed on the label, (2) not injure humans, crops, livestock, wildlife, or damage the total environment, and (3) not result in illegal residues in food or feed.

The FIFRA was administered by the Department of Agriculture until the authority was transferred to the Environmental Protection Agency (EPA) when it was established in December 1970. The administering Agency has authority to cancel a pesticide registration when the registered use of the product is in violation of the Act or poses a serious hazard to humans on their environment. The registrant is entitled to appeal the cancellation notice through a process that can include public hearings and scientific advisory committees.

Suspension of a pesticide registration, unlike cancellation, halts interstate shipments immediately and is reserved for those products that present an imminent hazard.

The Pesticide Amendment to the Federal Food, Drug, and Cosmetic Act is a law closely related to the FIFRA and FEPCA. It provides protection to consumers from harmful pesticide residues in food. The Amendment requires that, where necessary to protect the public health, a tolerance or legal limit be established for any residues that might remain in or on a harvested food or feed

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crop as a result of the application of a chemical for pest control. Tolerances are based on chemical and toxicological data showing that the residues are safe for consumption.

The authority to establish tolerance levels was transferred from the Food and Drug Administration to EPA in December 1970. The enforcement of tolerances remains the responsibility of the Food and Drug Administration of the Department of Health, Education, and Welfare.

Provisions of the New Law: Some of the provisions of the 1972 Act are:

- * The use of any registered pesticide in a manner inconsistent with labeling instructions is prohibited, effective immediately. Civil and criminal penalties for misuse of pesticides are provided.
- * Known violations of the Act by farmers or other private applicators can result in fines of up to \$1,000.00 or 30 days imprisonment or both. Second and subsequent offenses are subject to fines of up to \$1,000.00.
- * Any registrant, commercial applicator, wholesaler, dealer, retailer, or other distributor who knowingly violates the law is liable to a \$5,000.00 or \$25,000.00 criminal fine or one year in prison or both.
- * Pesticides must be classified for general use or restricted use by October 1976.
- * The States will certify pesticide applicators for use of restricted pesticides. The Act allows four years for development of certification programs. Federal standards for certification must be set forth by October 1973, and the States must submit their certification programs based on these standards by 1975. The State programs must be approved within one year of submission.
- * The Administrator may issue orders stopping the sale, use, and/or requiring the removal of any product when it appears that the product is in violation of the Act or the registration has been suspended and finally cancelled. Products in violation of the Act may also be seized.
- * Pesticide manufacturing plants must be registered by October 1974.
- * EPA is required to develop procedures and regulations for the storage and disposal of pesticide containers. They must accept at convenient locations for disposal, pesticides which have had registrations suspended and then cancelled.
- * The Agency is authorized to issue experimental permits, conduct research on pesticides and alternatives, and monitor pesticide use and presence in the environment.

- * The owners of certain pesticides where registrations are suspended and finally cancelled are entitled to indemnification.
- * States are authorized to issue limited registrations for pesticides intended for special local needs.
- * States may impose more stringent regulations on pesticides than the Federal Government, except for packaging and labeling.
- * The views of the Secretary of Agriculture are required to be solicited before the publishing of regulations under the Act.
- * Federal registration of all pesticide products, whether they are shipped in interstate or intrastate commerce, is required under the new Act.

The reader is encouraged to consult the closest regional office of the Environmental Protection Agency for further information and details on the provisions and regulations of the Federal Environmental Pesticide Control Act of 1972.

Recent EPA Actions:

Cancellation proceedings were initiated under the FIFRA against aldrin, DDT, dieldrin, and mirex. After extensive public hearings, nearly all remaining registered uses of DDT were cancelled in June 1972, the order to become effective December 31, 1972. This decision was based on potential future hazards to man and his environment.

The use of mirex against the imported fire ant in the Southeastern United States has been limited, primarily because of the hazard to aquatic life.

Cancellation of the use of 2,4,5-T on food crops has been continued, pending the outcome of a public hearing on possible risk of injury resulting from its application.

In June 1972, cancellation of most of the major registered uses of aldrin and dieldrin on corn, fruit, and for seed treatments was continued pending the conclusion of a public hearing and a final decision of EPA on possible use restrictions.

Suspension and cancellation notices for mercury-bearing pesticides were issued. Used heavily by industry, mercury builds up in the food chain and persists in the environment.

All interstate shipments of pesticides registered for use in the control of predatory animals were halted. This action was taken following the discovery that their use was destroying valuable wildlife resources including some endangered species.

CHEMICAL, PHYSICAL, AND BIOLOGICAL PROPERTIES OF HERBICIDES

(Alphabetically by common name)

[LD₅₀ values are given in milligrams of herbicide per kilogram of body weight of rats or specified animal. For comparative purposes, LD₅₀ for aspirin is 1,240 mg. per kg. EC, emulsifiable concentrate; G, granular base; oil, oil soluble; OS, soluble in organic solvents, WML, water-miscible liquid; WP, wettable powder; WS, water soluble, WSA, water-soluble salt; WSC, water-soluble concentrate; WSP, water-soluble powder; WSS, water-soluble solid.]

Acrolein. CHEMICAL NAME: acrolein. LD₅₀: 46. FORMULATION: WS. REMARKS: Controls submersed aquatic weeds and algae; highly volatile, flammable vapor; very irritating to eyes and respiratory passages; toxic to mammals and aquatic life; must be applied from special containers under nitrogen gas pressure. Caution: Great care must be used in storage of partially empty containers. Acrolein is subject to polymerization, an explosive reaction. Follow label instructions carefully.

Ametryne. CHEMICAL NAME: 2-(ethylamino)-4-(isopropylamino)-6-(methylthio)-s-triazine. LD₅₀: 1,110. FORMULATION: EC, WP. REMARKS: Controls most annual broadleaf weeds and grasses when used as preemergence treatment; also effective as postemergence herbicide and has considerable activity through foliage contact.

Amitrole. CHEMICAL NAME: 3-amino-s-triazole. LD₅₀: 2,500. FORMULATION: WSP. REMARKS: Controls bermudagrass, Canada thistle, cattails, hoary cress, horsetail rush, leafy spurge, poison ivy, poison oak, pricklyash, quackgrass, Russian knapweed, sedges, tules, white ash; applied as a spray to foliage in spring; retreatments made as needed.

Amitrole-T. CHEMICAL NAME: 3-amino-s-triazole plus ammonium thiocyanate. FORMULATION: WML. REMARKS: Controls quackgrass, reed canarygrass, waterhyacinth; formulation more effective than amitrole alone.

AMS. CHEMICAL NAME: ammonium sulfamate. LD₅₀: 3,900. FORMULATION: WS, WSP. REMARKS: Controls broadleaf weeds and woody plants adjacent to sensitive crop plants; controls weeds after emergence; prevents stumps from sprouting when applied to cut surface; crystals or concentrated solution will kill large trees by filling ax chips made around base of tree.

Atrazine. CHEMICAL NAME: 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine. LD₅₀: 3,080. FORMULATION: WP. REMARKS: Controls germinating weed grasses and broadleaf weeds; use as preplanting, soil-incorporated treatment to control quackgrass; chemical residues in soil may injure susceptible crops year after treatment.

Barban. CHEMICAL NAME: 4-chloro-2-butynyl m-chlorocarbonilate. LD₅₀: 1,350. FORMULATION: EC. REMARKS: Controls wild oats and wildrye when treated in 2-leaf stage.

Use Pesticides Safely-Follow the Label

- Benefin. CHEMICAL NAME: N-butyl-N-ethyl-alpha,alpha,alpha-trifluoro-2,6-dinitro-p-toluidine. LD₅₀: 10,000. FORMULATION: EC. REMARKS: Controls germinating broadleaf weeds and weed grasses.
- Bensulide. CHEMICAL NAME: O,O-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl)benzenesulfonamide. LD₅₀: 770. FORMULATION: EC, G. REMARKS: Controls germinating annual broadleaf weeds and weed grasses; herbicide persists in soil for extended period.
- Boron compounds (borax, sodium pentaborate, boron trioxide, anhydrous sodium biborate, and mixtures). FORMULATION: G or WSP. REMARKS: For soil sterilization to control deep-rooted perennial weeds and growth of all vegetation.
- Bromacil. CHEMICAL NAME: 5-bromo-3-sec-butyl-6-methyluracil. LD₅₀: 5,200. FORMULATION: WP. REMARKS: For control of germinating weed grasses and most herbaceous broadleaf weeds; especially effective on daisies and goldenrod; gives long-term control; persists in soils.
- Bromoxynil. CHEMICAL NAME: 3,5-dibromo-4-hydroxybenzonitrile, LD₅₀: 5,200. FORMULATION: EC. Used on noncropland to control wide range of broadleaf weeds and grasses; at low rates shows selectivity in certain deep-rooted crops.
- Butylate. CHEMICAL NAME: S-ethyl diisobutylthiocarbamate. LD₅₀: 4,659-5,431. FORMULATION: ED. REMARKS: Controls nutsedges, germinating, quackgrass, johnsongrass, annual grasses, lambsquarters, redroot pigweed, purslane, annual morningglory, Florida purslane, velvetleaf and others; must be mechanically incorporated into the soil to a depth of 2 to 3 inches immediately after application.
- Cacodylic acid. CHEMICAL NAME: hydroxydimethylarsine oxide. LD₅₀: 830. FORMULATION: WSS. REMARKS: Quickly kills most vegetation; used mainly to renovate turf.
- CDAA. CHEMICAL NAME: N,N-diallyl-2-chloroacetamide. LD₅₀: 750. FORMULATION: EC, G. REMARKS: Controls germinating weed grasses; causes temporary stunting of broadleaf weeds; may cause serious irritation to eyes; wear goggles and rubber gloves during applications.
- CDEC. CHEMICAL NAME: 2-chloroallyl diethyldithiocarbamate. LD₅₀: 850. FORMULATION: EC, G. REMARKS: Controls germinating weed grasses, excellent for henbit; moderate control of chickweed; prolonged contact with skin will cause irritation.
- Chloramben. CHEMICAL NAME: 3-amino-2,5-dichlorobenzoic acid. LD₅₀: 3,500. FORMULATION: G, WML, or WSC. REMARKS: Controls germinating barnyardgrass, crabgrass, curly dock, lambsquarters, pigweed, ragweed, smartweed.

- Chlorbromuron. CHEMICAL NAME; 3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea. LD₅₀: 2,150. FORMULATION: WP. REMARKS: Controls most annual grasses and broadleaf weeds. Rice, beets, okra, cucurbits, cole crops, tomatoes, flax and strawberries unusually sensitive.
- Chloroxuron. CHEMICAL NAME: 3-[p-(p-chlorophenoxy)phenyl]-1,1-dimethylurea. LD₅₀: 3,700. FORMULATION: WP. REMARKS: Controls annual grasses and broadleaf weeds.
- Chlorpropham. CHEMICAL NAME: isopropyl m-chlorocarbanilate. LD₅₀: 5,000-7,500. FORMULATION: EC, G. REMARKS: Controls germinating weed grasses, carpetweed, chickweed, knotweed, lambsquarters, morningglory, pigweed, purslane, smartweed; use in combination with other herbicides for multiple weed control.
- Copper sulfate (blue vitriol, bluestone). FORMULATION: Ws. REMARKS: Controls algae in ponds, lakes, other aquatic sites; corrosive to metals; at 50 p.p.m. hazardous to warmblooded animals; below 1.0 p.p.m.w. copper ion equivalent to 4 p.p.m.w. copper sulfate, U.S. Public Health Service considers concentrations harmless in potable water supplies; toxic to fish at 1 p.p.m.w. (especially in soft water and in the presence of zinc).
- Cyanazine. CHEMICAL NAME: 2-[[4-chloro-6-(ethylamino)-s-triazin-2-yl]amino]-2-methylpropionitrile. LD₅₀: to rats 334 mg/kg. FORMULATION: WP, G, and water dispersible liquid. REMARKS: Selective preemergence herbicide for control of annual grasses and broadleaf weeds in corn.
- Cycloate. CHEMICAL NAME: S-ethyl N-ethylthiocyclohexanecarbamate. LD₅₀: 3,190. FORMULATION: EC. REMARKS: Controls annual broadleaf weeds and grasses in sugar beets.
- Cyprazine. CHEMICAL NAME: 2-chloro-4-(cyclopropylamino)-6-(isopropyl = amino)-s-triazine. LD₅₀: 1200 ± 200 mg/kg. FORMULATION: EC. REMARKS: A selective postemergence herbicide for control of seedling broadleaf weeds and grasses in corn. Broadcast postemergence applications should be made before corn reaches a height of 10 inches, and before weeds reach a height of 4 inches.
- Cypromid. CHEMICAL NAME: 3',4'-dichlorocyclopropanecarboxanilide. LD₅₀: 200. FORMULATION: EC. REMARKS: Controls barnyardgrass, cocklebur, crabgrass, giant foxtail, green foxtail, johnsongrass, lambsquarters, pigweed, purslane, smartweed, velvetleaf, wild morningglory, yellow foxtail, and some other broadleaf weeds and grasses in field corn.
- Dalapon. CHEMICAL NAME: 2,2-dichloropropionic acid. LD₅₀: 7,570-9,330. FORMULATION: WS. REMARKS: Controls growing annual weeds, bermudagrass, johnsongrass, quackgrass, other perennial weeds, cattails, common reed; most effective in crops when applied in combination with tillage and cultural practices.

DCPA. CHEMICAL NAME: dimethyl tetrachloroterephthalate. LD₅₀: 3,000. FORMULATION: WP. REMARKS: Controls germinating annual weeds and weed grasses, highly selective on many crop and ornamental plants.

Diallate. CHEMICAL NAME: S-(2,3-dichloroallyl) diisopropylthiocarbamate. LD₅₀: 395. FORMULATION: ED, G. REMARKS: Controls germinating wild oats; highly selective herbicide with very little herbicidal activity on any other weed.

Dicamba. CHEMICAL NAME: 3,6-dichloro-o-anisic acid. LD₅₀: 2,900. FORMULATION: WSa. REMARKS: Controls emerged Canada thistle, chickweed, corn cockle, dogfennel, field bindweed, red sorrel, Russian knapweed, other deep-rooted perennial weeds.

Dichlobenil. CHEMICAL NAME: 2,6-dichlorobenzonitrile. LD₅₀: 3,160. FORMULATION: G, WP. REMARKS: Controls germinating broadleaf annual weeds, annual weed grasses, brackenfern, nutsedge, wild strawberry, many submersed vascular aquatic weeds and chara.

Dichlone. CHEMICAL NAME: 2,3-dichloro-1,4-naphthoquinone. LD₅₀: 1,300. FORMULATION: WP. REMARKS: May create a food chain hazard to microfauna when used as an algicide.

Dinoseb. CHEMICAL NAME: 2-sec-butyl-4,6-dinitrophenol. LD₅₀: 5-60. FORMULATION: EC, G. REMARKS: Controls many germinating and established broadleaf weeds and weed grasses; imparts yellow coloring to clothes and skin; avoid inhaling or coming in contact with sprays; crop may be injured if extremely high temperatures occur in 2-week period after pre-emergence spray.

Diphenamid. CHEMICAL NAME: N,N-dimethyl-2,2-diphenylacetamide. LD₅₀: 1,000. FORMULATION: G, WP. REMARKS: Controls many germinating weed grasses and certain broadleaf weeds.

Diquat. CHEMICAL NAME: 6,7-dihydrodipyrido[1,2-a:2',1'-c]pyrazinediium ion. LD₅₀: 400-440. FORMULATION: WS, WSa. REMARKS: Controls many aquatic weeds; is general contact herbicide for control of many established weeds: desiccant in harvesting certain crops; deactivated on contact with soil.

Diuron. CHEMICAL NAME: 3-(3,4-dichlorophenyl)-1,1-dimethylurea. LD₅₀: 3,400-7,500. FORMULATION: G, WML, WP. REMARKS: Controls annual broadleaf weeds and perennial grasses.

DSMA. CHEMICAL NAME: disodium methanearsonate. LD₅₀: 1,800. FORMULATION: G, WP, WS. REMARKS: General contact herbicide used as spot treatment to control many weeds in early stages of growth.

- Endothall. CHEMICAL NAME: 7-oxabicyclo[2,2,1]heptane-2,3-dicarboxylic acid. LD₅₀: 38-51. FORMULATION: G, WS, WsA. REMARKS: Controls germinating weeds in certain crops and some submersed aquatic weeds; fish are tolerant to relatively high concentrations of disodium salts, but dimethylalkanolamine salts are toxic at concentrations of 0.5 p.p.m.w.
- EPTC. CHEMICAL NAME: S-ethyl dipropylthiocarbamate. LD₅₀: 1,630. FORMULATION: EC, G. REMARKS: Controls germinating broadleaf weeds and annual grasses; high rate controls quackgrass; herbicide sometimes incorporated in soil in early spring before planting.
- Ethylene glycol bis (trichloracetate) LD₅₀: 7,000. FORMULATION: EC; L. REMARKS: Used as a spot treatment on established weeds in cotton and soybean plantings.
- Erbon. CHEMICAL NAME: 2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate. LD₅₀: 1,120. FORMULATION: EC. REMARKS: Controls established morning-glory, perennial rye, bermudagrass in noncrop areas.
- Fenac. CHEMICAL NAME: (2,3,6-trichlorophenyl) acetic acid. LD₅₀: 2,500-3,000. FORMULATION: G, WS, WsA, WSP. REMARKS: Controls bindweed, puncturevine, Russian thistle, seedling johnsongrass, seedling annual broadleaf weeds, weed grasses, submersed aquatic weeds; persists in soil for long periods when used as soil sterilant.
- Fenuron. CHEMICAL NAME: 1,1-dimethyl-3-phenylurea. LD₅₀: 6,400. FORMULATION: G, WP. REMARKS: Controls many species of brush; nonselective for control on noncultivated land.
- FenuronTCA. CHEMICAL NAME: 1,1-dimethyl-3-phenylurea mono(trichloroacetate). LD₅₀: 4,00-5,700. FORMULATION: G. REMARKS: Non-selective herbicides for use in non-crop areas.
- Ferrous Sulfate. CHEMICAL NAME: Ferrous sulfate. LD₅₀: 5,000. FORMULATION: Crystal.
- Fluometuron. CHEMICAL NAME: 1,1-dimethyl-3-(alpha, alpha, alpha-trifluoro-m-tolyl)urea. LD₅₀: 6,000. FORMULATION: WP. REMARKS: Controls many broadleaf and annual grass weeds as preemergence or postemergence treatment.
- Fluorodifen. CHEMICAL NAME: p-nitrophenyl alpha, alpha, alpha-trifluoro-2-nitro-p-tolyl ether. LD₅₀: 15,000. FORMULATION: EC. REMARKS: Selective herbicide for preemergence weed control in soybeans, blackeyed peas, cowpeas, field beans, field peas, green beans, and other large seeded legumes (see label).
- Linuron. CHEMICAL NAME: 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea. LD₅₀: 1,500. FORMULATION: WP. REMARKS: Controls broadleaf weeds and weed grasses when used as preemergence or postemergence treatment; incorporated in soil for preemergence control; contact for postemergence of seedling weeds in corn.

MCPA. CHEMICAL NAME: [(4-chloro-o-tolyl)oxy]acetic acid. LD₅₀: FORMULATION: EC, WS, Wsa. REMARKS: Controls growing broadleaf annual weeds, perennial weeds including Canada thistle; salt formulations recommended near susceptible plants such as cotton, flowers, grapes, ornamentals, tomatoes.

MCPB. CHEMICAL NAME: 4-[(4-chloro-o-tolyl)oxy]butyric acid. LD₅₀: 375-1,200. FORMULATION: EC, WS, Wsa. REMARKS: Controls growing broadleaf annual weeds, perennial weeds including Canada thistle; salt formulations recommended near susceptible plants such as cotton, flowers, grapes, ornamentals, tomatoes.

Metham. CHEMICAL NAME: sodium methyldithiocarbamate. LD₅₀: 3,000-5,000. FORMULATION: WML. REMARKS: Soil fumigant; controls many annual weeds; drench onto soil with water or mix in surface 6-inch layer of soil, then thoroughly wet; 7-14 days waiting period required before planting crop.

Methyl bromide. LD₅₀: 35. FORMULATION: Compressed gas. REMARKS: Soil fumigant; controls many weeds, weed seed, rootstocks; apply under gas-proof cover after thorough tillage; methyl bromide is very dangerous to man and warmblooded animals; absorbed through skin as well as by inhalation. Observe restrictions for use with great care.

Metobromuron. CHEMICAL NAME: 3-(p-bromophenyl)-1-methoxy-1-methylurea. LD₅₀: 2,000-3,000. FORMULATION: WP. REMARKS: Controls many annual grasses and broadleaf weeds as a preemergence treatment.

Molinate. CHEMICAL NAME: S-ethyl hexahydro-1H-azepine-1-carbothioate. LD₅₀: 720. FORMULATION: EC or G. REMARKS: Controls many germinating annual broadleaf weeds and weed grasses including wild oats.

Monuron. CHEMICAL NAME: 3-(p-chlorophenyl)-1,1-dimethylurea. LD₅₀: 3,600. FORMULATION: G, WML, WP. REMARKS: Controls many germinating broadleaf weeds and weed grasses; use in certain row crops and as soil sterilant in noncrop areas.

MonuronTCA. CHEMICAL NAME: 3-(p-chlorophenyl)-1,1-dimethylurea mono=(trichloroacetate). LD₅₀: 2,300-3,700. FORMULATION: WP, G. REMARKS: Non-selective soil sterilization in non-crop areas, persistent for 6 to 18 months.

MSMA. CHEMICAL NAME: monosodium methanearsonate. LD₅₀: 700. FORMULATION: EC, Wsa. REMARKS: Always use with surfactant because thorough coverage is extremely important; very useful for postemergence control of young crabgrass in turf and for control of dallisgrass.

Naptalam. CHEMICAL NAME: N-1-naphthylphthalamic acid. LD₅₀: 8,200. FORMULATION: EC, G, WP. REMARKS: Controls germinating broadleaf weeds and weed grasses.

Naphtha. (see Oils, aromatic).

Use Pesticides Safely-Follow the Label

- Neburon. CHEMICAL NAME: 1-butyl-3-(3,4-dichlorophenyl)-1-methylurea. LD₅₀: 3,400-7,500. FORMULATION: WP. REMARKS: Controls many germinating broadleaf weeds and weed grasses.
- Nitralin. CHEMICAL NAME: 4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline. LD₅₀: 2,000. FORMULATION: WP. REMARKS: Preemergence treatment for control of annual grasses and broadleaf weeds.
- Nitrofen. CHEMICAL NAME: 2,4-dichlorophenyl-p-nitrophenyl ether. LD₅₀: 2,630. FORMULATION: EC. REMARKS: Controls many germinating annual broadleaf weeds and weed grasses.
- Nitrogen solutions. CHEMICAL NAME: ammonium nitrate, sodium nitrate. FORMULATION: WS. REMARKS: Controls young growing weeds in emerged corn.
- Norea. CHEMICAL NAME: 3-(hexahydro-4,7-methanoindan-5-yl)-1,1-dimethylurea. LD₅₀: 1,476. FORMULATION: WP. REMARKS: Controls germinating broadleaf weeds and weed grasses.
- Oils, aromatic. CHEMICAL NAME: aromatic solvent, xylene, naphtha, solvent naphtha, petroleum naphtha, Stoddard solvent. LD₅₀: 2,000. FORMULATION: Oil. REMARKS: Controls young broadleaf weeds and weed grasses including johnsongrass; also submersed aquatic weeds in irrigation canals and drains; toxic to fish.
- Paraquat. CHEMICAL NAME: 1,1'-dimethyl-4,4'-bipyridinium ion. LD₅₀: 150. FORMULATION: WML, WS. REMARKS: Use as general contact weed killer or directed sprays on young weeds.
- PCP. CHEMICAL NAME: pentachlorophenol. LD₅₀: 27-80. FORMULATION: EC, flakes, pellets, WP. REMARKS: Controls bermudagrass, crabgrass, fox-tails, johnsongrass, lambsquarters, pigweed, many other seedling grasses and broadleaf weeds; irritating to skin, nose, eyes; absorbed through skin.
- Pebulate. CHEMICAL NAME: S-propyl butylethylthiocarbamate. LD₅₀: 921-1,120. FORMULATION: EC, G. REMARKS: Controls some germinating broadleaf weeds and several weed grasses.
- Phenmedipham. CHEMICAL NAME: methyl m-hydroxycarbanilate m-methylcarbanilate. LD₅₀: 8,000. FORMULATION: EC. REMARKS: Controls many annual weeds postemergence in sugarbeets; apply when weeds are in 2 to 4 leaf stage.
- Picloram. CHEMICAL NAME: 4-amino-3,5,6-trichloropicolinic acid. LD₅₀: 8,200. FORMULATION: G, WML. REMARKS: Controls several brush species; use on noncropland including utility rights-of-way and industrial storage areas.
- Prometone. CHEMICAL NAME: 2,4-bis(isopropylamino)-6-methoxy-s-triazine. LD₅₀: 2,980. FORMULATION: EC. REMARKS: Controls many germinating broadleaf weeds and weed grasses in noncropland.

- Prometryne. CHEMICAL NAME: 2,4-bis(isopropylamino)-6-(methylthio)-s-triazine. LD₅₀: 3,750. FORMULATION: WP. REMARKS: Controls many germinating broadleaf weeds and weed grasses in noncropland.
- Pronamide. CHEMICAL NAME: N-(1,1-dimethylpropynyl)-3,5-dichlorobenzamide. LD₅₀: 5,620-8,350. FORMULATION: WP. REMARKS: Apply after last cutting of the crop (September to February) to control quackgrass and annual weeds in established small seeded legumes; control of annual weeds in lettuce; and control of annual bluegrass in bermudagrass and other southern turf.
- Propachlor. CHEMICAL NAME: 2-chloro-N-isopropylacetanilide. LD₅₀: 1,580. FORMULATION: G, WP. REMARKS: Preemergence treatment for control of annual grasses and certain broadleaf weeds.
- Propanil. CHEMICAL NAME: 3',4'-dichloropropionanilide. LD₅₀: 1,384-2,270. FORMULATION: EC. REMARKS: Controls germinating barnyardgrass in rice.
- Propazine. CHEMICAL NAME: 2-chloro-4,6-bis(isopropylamino)-s-triazine. LD₅₀: 5,000. FORMULATION: WP. REMARKS: Controls germinating broadleaf weeds and weed grasses.
- Propham. CHEMICAL NAME: isopropyl carbanilate. LD₅₀: 5,000. FORMULATION: EC, G, WP. REMARKS: Controls germinating annual grasses, chickweed, some broadleaf weeds.
- Pyrazon. CHEMICAL NAME: 5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone. LD₅₀: 3,000. FORMULATION: WP. REMARKS: Controls germinating broadleaf weeds including lambsquarters.
- Siduron. CHEMICAL NAME: 1-(2-methylcyclohexyl)-3-phenylurea. LD₅₀: 5,000. FORMULATION: WP. REMARKS: Controls hairy and smooth crabgrass, downy brome, and foxtails in turf and in some crops. Kentucky bluegrass, red fescue; several bentgrasses exceptionally tolerant of this material.
- Silvex. CHEMICAL NAME: 2-(2,4,5-trichlorophenoxy) propionic acid. LD₅₀: 375-1,200. FORMULATION: EC, G, WSA. REMARKS: Controls young broadleaf weeds including chickweed, curly dock, henbit, lambsquarters, some floating and submersed aquatic weeds.
- Simazine. CHEMICAL NAME: 2-chloro-4,6-bis(ethylamino)-s-triazine. LD₅₀: 5,000. FORMULATION: G, WP. REMARKS: Controls germinating annual broadleaf weeds and weed grasses; controls vegetation on noncropland; long residual action.
- Sodium chlorate. LD₅₀: 5,000. FORMULATION: WSP, WSS. REMARKS: Use as soil sterilant to control all vegetation; leaves soil unproductive 1-4 years depending on precipitation, temperature, soil type; sandy soils of humid areas require higher applications than heavy soils of arid regions; toxicity persists longer in arid regions.
- Stoddard solvent. (see Oils, aromatic.)

Surfactants. CHEMICAL NAME: soaps or synthetic detergents and emulsifiers. REMARKS: Increase wetting, spreading, and sticking properties of herbicidal sprays; at 0.1 percent or greater may change activity of herbicide on various species.

Table salt. CHEMICAL NAME: sodium chloride. LD₅₀: 3,320. FORMULATION: WSS. REMARKS: Salt sometimes used as herbicide and commonly used as food seasoning and preservative; included here so reader may use LD₅₀ value of this material for comparative purposes.

TCA. CHEMICAL NAME: trichloroacetic acid. LD₅₀: 5,000. FORMULATION: WS, WSA, WSP. REMARKS: Controls many germinating and established perennial grasses, including johnsongrass, quackgrass; residual toxicity may persist year or longer at high rates.

Terbacil. CHEMICAL NAME: 3-tert-butyl-5-chloro-6-methyluracil. FORMULATION: WP. REMARKS: For selective control of many annual and some shallow-rooted perennial weeds growing in deep-rooted perennial crops.

Terbutol. CHEMICAL NAME: 2,6-di-tert-butyl-p-tolyl methylcarbamate. LD₅₀: 34,600. FORMULATION: G, WP. REMARKS: Preemergence treatment for crabgrass control in established turf.

Terbutryn. CHEMICAL NAME: 2-(tert-butylamino)-4-(ethylamino)-6-(methylthio)-s-triazine. LD₅₀: 2,400-2,980. FORMULATION: WP. REMARKS: Control of annual broadleaf weeds and grasses in winter and wheat peas and sorghum but has performed well in barley; presently restricted to use in Oregon and Washington.

Triallate. CHEMICAL NAME: S-(2,3,3-trichloroallyl) diisopropylthiocarbamate. LD₅₀: 1,675-2,165. FORMULATION: EC. REMARKS: Controls germinating wild oats in various crops.

Trifluralin. CHEMICAL NAME: alpha, alpha, alpha-trifluoro-2,6-dinitro-N, N-di-propyl-p-toluidine. LD₅₀: 10,000. FORMULATION: EC, G. REMARKS: Controls many germinating annual broadleaf weeds and weed grasses.

Vernolate. CHEMICAL NAME: S-propyl dipropylthiocarbamate. LD₅₀: 1,780. FORMULATION: EC, G. REMARKS: Broadleaf weeds and weed grasses killed by preemergence treatments.

Weeding oils. (see Oils, aromatic).

2,3,6-TBA. CHEMICAL NAME: 2,3,6-trichlorobenzoic acid. LD₅₀: 750-1,000. FORMULATION: EC, G, OS, WML, WSA. REMARKS: Preemergence and post-emergence treatments for control of bindweed, quackgrass, wild garlic, some perennial broadleaf herbaceous weeds; brush treatment may prevent crop production for 1-3 years.

- 2,4-D. CHEMICAL NAME: (2,4-dichlorophenoxy) acetic acid. LD₅₀: 300-1,000.
FORMULATION: EC, WML, WS, WSa. REMARKS: Controls many germinating and established annual broadleaf weeds including lambsquarters, mustard, pigweed; many floating and submersed aquatic weeds; do not use volatile esters near susceptible plants such as cotton, flowers, grapes, ornamentals, tomatoes; some esters are quite toxic to fish.
- 2,4-DB. CHEMICAL NAME: 4-(2,4-dichlorophenoxy) butyric acid. LD₅₀: 300-1,000.
FORMULATION: EC, WML, WS, WSa. REMARKS: Controls many broadleaf weeds and weed grasses.
- 2,4,5-T. CHEMICAL NAME: (2,4,5-trichlorophenoxy) acetic acid. LD₅₀: 300.
FORMULATION: EC, WML, WS, WSa. REMARKS: Broadleaf weeds; do not use volatile esters near such susceptible plants as cotton, flowers, grapes, ornamentals, tomatoes.

GENERAL CONSIDERATIONS IN USE OF HERBICIDES

Purchasing Herbicides

Formulations

Most herbicides are purchased as a commercial formulation that contains the herbicide and can be (1) dissolved, emulsified, or suspended in a liquid carrier, (2) distributed dry by a spreader or by hand, or (3) injected into soil for vaporization and fumigation. Often an emulsifier, spreader, sticker, or other surfactant is added to facilitate dilution and adhering capacity or to increase wetting of plants. Many formulations contain inactive fillers that serve as diluents only. For example, there may be 2, 3, 4, or 6 pounds of active herbicide in a gallon of liquid formulation weighing as much as 10 pounds or 4, 10, 20, 50, or 80 percent of active chemical in a granule, pellet, or powder formulation. Avoid use of carriers or additives to herbicides used in or near aquatic situations that may pose a hazard to fish or wildlife (PCB's, phthalates, and others). See list of metric equivalents for weight, volume, area, and linear dimensions in the appendix.

Active Chemical Content

Although the carrier components contained in herbicides, such as emulsifiers, solvents, and other adjuvants, often improve mixing, spraying and weed-control results, the economic value of a herbicide is largely dependent on the relative amount of phytotoxic chemical that is contained per gallon or pound. One of the best guides to use in purchasing a commercial herbicide is the price per pound of active chemical. The containers for all commercial herbicides have labels that state the amount of active chemicals contained in the particular product. This is expressed in percentage of active ingredient or acid equivalent for solids, and in pounds per gallon for liquids. Where a formulation contains a mixture of herbicides, the amount of each herbicide is given on the label and should be considered in determining the relative value of the mixture.

Acid equivalent is commonly used to express the active chemical in dalapon and the phenoxy, benzoic, and picolinic acid herbicides, such as 2,4-D, silvex, 2,3,6-TBS, and picloram. Phenol equivalent is used to express the active chemical in dinitrophenol derivatives. For most other compounds the active chemical content is expressed as active ingredient.

Usually the concentrated formulations are more economical to use than diluted concentrations when the herbicide is applied in a spray. For example, 2,4-D formulations that contain 4 pounds of acid equivalent per gallon nearly always cost less per pound of 2,4-D than formulations containing only 1 or 2 pounds of 2,4-D acid equivalent per gallon. On the other hand, herbicides to be broadcast dry in granules or pellets may require diluted concentrations as low as 4, 10, or 20 percent to permit precise and uniform application.

Volatility

Another important consideration in purchasing 2,4-D, or other phenoxy herbi-

cides for certain weeds and special situations such as aquatic uses, is the type of the herbicide derivative such as the amine or high-volatile or low-volatile ester to be used. When vapors from the herbicide are likely to injure adjacent crops or plants, an emulsifiable acid, amine salt, or a low-volatile formulation ester should be used. Esters of 2,4-D are classified as being of high or low volatility according to the degree of vaporization that occurs. In general, methyl, ethyl, isopropyl, butyl, and amyl esters are considered highly volatile. The butoxyethyl, butoxyethoxypropyl, ethoxyethoxypropyl, propyleneglycolbutylether, isooctyl, and other high molecular weight esters are low volatile.

Granular Herbicides

Granular herbicides are formulated for application as dry granules. They are applied with specialized granular pesticide spreading equipment or modified fertilizer spreaders.

Granules are prepared in several ways. Some herbicides are impregnated on granules of clay, vermiculite, or crop residues, such as corncocks, by spraying, dipping, or exposing the granules to herbicide vapors. Granules are also prepared by mixing a herbicide with finely ground clay or fertilizer salts, and particles are formed by extrusion or prilling.

One of the most important properties of granular herbicides is physical selectivity or the tendency for particles to bounce off foliage and other plant parts to the soil or to settle to the bottom of ponds, lakes, and other bodies of water. This physical selectivity enhances the chemical selectivity of herbicides used on growing crops or on submersed aquatic weeds. Sprays are often intercepted by crop foliage and their effectiveness in killing germinating weed seeds in the soil is reduced. Granules tend to bounce off and sift down through the foliage to the soil where they are needed.

Granular herbicides are of special interest in the growing of horticultural crops, because their physical selectivity helps to broaden the use of a few effective herbicides to cover a relatively large number of crops. Therefore they have been used rather extensively in horticultural crops after clean cultivation. Granules also fill a specific need in transplanted crops, where preemergence herbicide treatments cannot be used. As a matter of convenience, granular herbicides have also been used extensively in preplant soil incorporated and preemergence treatments of horticultural crops.

Because of the scarcity in many areas of clean water supplies for spraying and the need for extra labor and equipment for water hauling, granular herbicides have been used in several field row crops and in ranges and pastures. Granular forms of some herbicides are also useful in controlling aquatic weeds and weeds in noncropland areas, including ditchbanks, rights-of-way, and industrial sites.

Numerous experiments have shown that granules and sprays of many herbicides are equally effective in controlling germinating weed seed in the soil. Each herbicide, whether used in spray or granular form, requires certain specific conditions of climate, soil, and application technique for best results. Re-

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commendations prepared by weed research specialists in State agricultural experiment stations and by the individual manufacturers of granular herbicides outline these necessary conditions.

Calculations For Herbicide Applications

Recommended rates of herbicide applications are stated in ounces or pounds per square rod, 1,000 square feet, or acre where the area to be treated can be measured. Where spot spraying of individual or small clumps of plants is necessary or where dense foliage of certain aquatic plants, brush, or trees is to be thoroughly wet, the concentration of spray is usually recommended in pounds of active chemical per 100 gallons of water or oil. To control submersed aquatic weeds, the rate is usually expressed as pounds of active chemical per acre-foot of water or as parts per million by weight of water (p.p.m.w.) in the area treated. In flowing water it is frequently necessary to prescribe both the concentration and the contact time for control.

1. To determine the amount of herbicide required for submersed aquatic weeds in impounded water, use the following data and calculations:

1 acre-foot of water weighs 2,722,500 pounds

1 p.p.m.w.=2.7 pounds of active herbicide in 1 acre-foot of water

(1) Pounds of herbicide = pounds per acre-foot (area in acres X average depth in feet)

Example;

Rate=4 pounds per acre-foot

Area=2.5 acres

Depth=3 feet (average), or 7.5 acre-feet

Then pounds of herbicide=4X7.5=30 pounds required

(2) Pounds of herbicide=p.p.m.w. X acre-feet X 2.7 pounds

Example;

Rate=1.5 p.p.m.w.

Volume=2 acres, 3 feet deep (average), or 6 acre-feet

Then pounds of herbicide=1.5 X 6X2.7=24.3 pounds required

2. To determine the amount of herbicide formulation required per acre, per acre-foot, per 100 gallons, or for a total area, use the following calculations:

(1) For liquid formulations-

Rate or amount required in pounds = gallons required
Pounds of herbicide per gallon

Examples;

Rate, 2 pounds per acre
4 pounds per gallon = 0.5 gallon

Concentration, 4 pounds per 100 gallons = 1 gallon

4 pounds per gallon

Amount requires, 24.3 pounds = 12.15 gallons

2 pounds per gallon

(2) For granule, dust, or pellet formulations-

Use the same calculations as for liquid formulations, except use pounds of active herbicide per pound of formulation (percent + 100) instead of pounds per gallon.

Examples:

Rate, 2 pounds per acre = 4 pounds

0.5 pound (50-percent material)

Concentration, 4 pounds per 100 gallons = 8 pounds

0.5 pound (50-percent material)

Amount required, 24.3 pounds = 121.5 pounds

0.20 pound (20-percent material)

3. To determine amount of herbicide needed to treat flowing water use the following calculations:

(1) For xylene treatments on a volume basis-

p.p.m. = gallons X 2,220

c.f.s. water flow X minutes applied

(2) For acrolein treatments on a weight basis-

p.p.m. - pounds active ingredient X 267

c.f.s. water flow X minutes applied

Mixing Spray Materials

When the capacity of a spray tank is not known or adequately marked to indicate the number of gallons at different levels of liquid in the tank, the best procedure is to set the sprayer or tank on a level base and gradually fill the tank with known quantities of water. As the water is added, the level of water should be marked in number of gallons or fractions of a gallon on the side of the tank or on a calibration rod or stick held perpendicularly in the center of the tank. Carefully measured markings are very useful in determining the volume in partly filled tanks.

To quickly approximate the capacity of a sprayer tank (all measurements in inches), use the following calculations:

Rectangular tanks: Capacity in gallons = length X width X depth X 0.00439

Example:

$$60 \times 36 \times 30 \times 0.00439 = 284.47 \text{ gallons}$$

Cylindrical tanks: Capacity in gallons=length X square of diameter X 0.0034

Example:

$$60 \times (36 \times 36) \times 0.0034 = 264.38 \text{ gallons}$$

Tanks with elliptical cross section: Capacity in gallons = length X square of (short diameter+long diameter)÷ 2 X 0.0034

Example:

$$60 \times \left(\frac{24+36}{2} \right)^2 \times 0.0034 = 183.6 \text{ gallons}$$

Never pour the liquid concentrate or dry herbicide formulation into an empty tank. Either fill the tank half full with water, add the herbicide, agitate, and complete the filling or start filling and add the herbicide gradually as the filling is continued. Agitate or stir until all solid material is dissolved. If a water-soluble powdered or crystalline form of herbicide is to be used with a liquid herbicide, dissolve the solid material in water first and then add and mix the liquid. If oil is to be used in an oil-water or invert emulsion, premix the emulsifier and the oil-soluble herbicide with the oil in a separate container and then add slowly to a partly filled tank of water with constant stirring or agitation. Before using, circulate the mixture until it is uniformly white.

Agitate suspensions of water-dispersible powders and oil-water emulsions constantly or frequently during spraying to maintain a uniform spray mixture. Use the spray mixture within 1 or 2 days, because some herbicides lose strength or the mixtures deteriorate on standing.

Suggestions for application rates of herbicides are based on the active ingredient or acid equivalent contained, and not on the total weight of the product.

APPLICATION EQUIPMENT

Results from using herbicides depend largely on how well or how poorly they are applied. This, in turn, depends on the suitability of the equipment for the particular situation and the care and skill with which the operator utilizes the equipment. Suitable equipment has been devised for nearly every situation requiring herbicide applications.

Ground sprayers include (1) hand sprayers of various types suitable for treating small patches, inaccessible areas, fence rows, and spot spraying; (2) boomless power sprayers (nozzle-cluster type) adapted for spraying roadsides and ditchbanks, under utility lines, and along fence rows; (3) power sprayers with tractor or truckmounted solid or sectional booms suitable for spraying field, pasture, range, and turf areas or for roadside and ditchbank spraying;

(4) power row-crop sprayers with various single and multiple nozzle arrangements or other devices for placement spraying; (5) power sprayers equipped with hoses, hand booms, or adjustable spray guns for application of foliage, basal, and stump treatments for brush control, spot treatments, and spraying around structures; and (6) power-driven mist blowers, ranging from hand-carried to truckmounted equipment, designed for dispersing concentrated sprays in finely atomized form at low volumes per acre and adapted for covering vegetation rapidly with a minimum of solution in inaccessible areas where wind drift can be utilized to advantage and where a hazard to desirable vegetation does not exist.

Boat or barge-mounted blowers, sprayers, booms with injection systems, and granular spreaders are used in distribution of aquatic herbicides to target species.

Aerial sprayers of many types have been developed on fixed-wing aircraft and helicopters. They have several advantages for application of herbicides at low volumes for many large field, rangeland, aquatic, and right-of-way areas when and where spray drift is not a hazard.

Suitable spreaders, ranging from hand-operated to power-driven and tractor-, truck-, or boat-mounted types, have been developed for most situations requiring application of granular or pellet herbicide formulations.

Calibration Of Application Equipment

The type and operating condition of application equipment for herbicides are important for efficient chemical weed control. This is especially true of sprayers. Accurate application of the desired rate and uniform distribution of spray solution or dry material are essential requirements for good results. A sprayer must uniformly distribute any quantity from 5 to 100 gallons or more per acre, because various weeds and locations may require a wide range of dilution for proper plant coverage. Sprayer or spreader output should be determined for each particular treatment operation.

A good method of calibration is to make initial adjustments to suit the machine and job requirements, and then make a trial run to determine the actual output of the machine. The herbicide spray mixture then should be prepared accordingly. The calibration should be repeated frequently to check nozzle orifice wear and other factors affecting performance. This is especially important when wettable powders or abrasive sprays are used.

How To Determine Per-Acre Output Of Sprayers

There are many methods of calibrating a sprayer. One method is given for calibrating each of the following types of ground and aerial sprayers.

Power Sprayers-Boom Type

1. Check to see whether all nozzles are discharging uniformly by spraying water through them at a uniform pressure and catching the discharge from each nozzle in a separate container. If the

discharge varies widely, replace all nozzle tips that give a much larger discharge.

2. Place the sprayer on level ground and fill the spray tank completely with water. Adjust pressure of the spraying as you will use it in the field.

3. Drive exactly one-eighth mile (660 feet) in a field or along a road, ditchbank, or other area to be sprayed at the speed you will use when spraying—usually 3 to 5 miles an hour. Measure from where the spraying begins. Mark the notch in which the throttle is set and keep it there when spraying.

4. Shut off the spray, return to the original spraying position on level ground, and measure the water required to refill the tank (a quart jar is satisfactory).

5. Calculate the output as follows:

$$\frac{\text{Number of quarts used} \times 16.5}{\text{Width of spray swath in feet}} = \text{gal./A}$$

Example:

Water used = 6 qt.

Spray swath width = 20 ft.

$$\text{Then } \frac{6 \times 16.5}{20} = 4.95 \text{ gal./A}$$

6. Divide the number of gallons the tank holds by the number of gallons your sprayer applied per acre (approximately 5). Multiply the number of acres one tankful will spray by the amount of herbicide to be used per acre. This gives the amount of herbicide to be used for each tankful.

Example;

Tank capacity = 55 gal.

Output = 5 gal./A

Desired rate of herbicide = 2 pt./A

$$\text{Then } \frac{55}{5} \times 2 = 22 \text{ pt., or } 2.75 \text{ gal. of herbicide}$$

In some row crops only narrow bands are sprayed, centered over each row, such as in preemergence treatments of cotton or soybeans. When treatments are made in this manner, the rate of treatment is in terms of the area treated and not per acre of actual crop. Thus in cotton with 36-in. row spacing, if a 12 in. band is treated at 1.5 lb./A (based on the area actually treated), the amount of chemical per acre of cotton is $\frac{12}{36} \times 1.5 = 0.5 \text{ lb.}$

Hand-Type Boom Sprayers

1. Fill knapsack or other hand sprayer to a marked point with water and spray while walking at a steady pace, maintaining a constant tank pressure for a distance of 330 ft. Multiply 330 by the width of swath in feet and divide by 43,560 to obtain the fraction of an acre sprayed.

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2. Refill to the marked point in the tank. Change the number of pints or quarts required to gallons by dividing by 8 or 4 and divide by the fraction of an acre sprayed.

Example:

Swath width = 4 ft.

Water required to refill = 5.5 pt., or 0.69 gal.

$$\frac{4 \times 330}{43,560} = 0.030 \text{ acre sprayed}$$

$$\frac{0.69}{0.03} = (\text{approximately}) 23 \text{ gal./A}$$

3. If too much spray is applied, walk faster or use a lower spraying pressure until the desired volume is achieved. Use the reverse procedure to obtain more volume. For larger volumes, replace with nozzle tips that have larger orifices.

4. Determine the amount of herbicide for each tankful by dividing the capacity of the tank in gallons by the number of gallons applied per acre to obtain the fraction of an acre each tankful will spray. Multiply that fraction by the desired rate of application per acre,

Example:

Capacity of tank = 3 gal.

Output per acre = 23 gal.

Rate per acre = 2 pt.

Then $\frac{3}{23} = 0.13$ acre per tank

$2 \times 0.13 = 0.26$ pint per tank

1 pint = 16 fluid ounces = 2 cups = 32 tablespoons

Then $0.26 \times 32 = 8.3$ tablespoons, or 0.5 cup, per tank, or 2.8 table-
spoons per gallon

Single-Nozzle Hand Sprayers

1. Use the same procedure as for hand-type boom sprayers, except measure off an area 10×43.6 (436 sq. ft.) to obtain the basic data for determining sprayer output and calculate as follows:

$$\frac{436}{43,560} = 0.01 \text{ acre sprayed}$$

If 2 pints, or 0.25 gal., is used, then

$$\frac{0.25 \text{ gallon}}{0.01 \text{ acre}} = 25 \text{ gal./A}$$

2. Determine the amount of herbicide for each tankful as follows:

Capacity of tank = 3 gal.

Output of sprayer = 25 gal./A

Desired rate per acre = 2 pt.

Then $\frac{3}{25} = 0.12$ acre per tankful

2 pints X 0.12 acre = 0.24 pt. per tankful

0.24 pt. X 32 = 7.7 tablespoons, or about 0.5 cup

Aerial Sprayers

1. To determine the rate of flow per acre and per minute, put a measured amount of spray in the tank or fill the tank with water to a definite level. Instruct the pilot to turn on the spray for a timed interval, for example 60 seconds, while flying level and straight at the speed to be used for spraying. Subtract the velocity of headwind from the airspeed to obtain the groundspeed. When the plane lands, drain and measure the liquid remaining in the tank; or with the plane in the location where the tank was filled, measure the amount required to refill the tank to the same level. Compute the flow rate in gallons per minute as follows:

S = groundspeed of plane per hour (assume 80 m.p.h. airspeed-5 m.p.h. headwind = 75 m.p.h.)

W = width of effective swath (not total swath) in feet (assume 40 ft.)

T = time sprayed in sec. (assume 60 sec., or $\frac{1}{60}$, or 0.017 hr.)

G = gal. used (assume 12.5)

Then: $S(\frac{75 \text{ m.p.h.}}{43,560 \text{ square feet}}) \times 5,280 \text{ feet per hour} \times W(40 \text{ feet}) \times T(0.017 \text{ hour}) = 6.18 \text{ acres}$

$$\text{Gallons per minute} = \frac{G}{T} = \frac{12.5}{1} = 12.5$$

$$\text{Gallons per acre} = \frac{12.5}{6.18} = 2.02$$

2. To determine the amount of herbicide required for each filling of the tank, divide the capacity of the tank by gallons per acre applied and multiply by the desired rate per acre.

Example:

If 120 gallons is the capacity of the tank and 2 pints per acre is the desired rate, then $\frac{120}{2.0} = 60$ acres sprayed per tank and 60 X 2 pints = 120 pints

(15 gal.) of herbicide required.

Aquatic Application or Injection Systems

1. Methods for calculating flow rates in canals etc.

2. Surveying techniques for ponds, lakes and larger streams, marshes, or flowages, and determination of water volume.

How To Determine Output Of Spreaders

For acceptable accuracy, calibration of mechanical broadcasters or spreaders for applying dry herbicide formulations must be done with the actual material under the conditions to be encountered in the field. Where calibration pans are available for spreaders to catch the material during trial runs and retain it for weighing, calibration is a simple procedure. Determining and maintaining a desired rate of application by hand or mechanical blowers, broadcasters, and other devices not equipped for catching the material applied require a more complicated and wasteful procedure.

Mechanical Spreaders With Calibration Pans

1. Fill the spreader at least half full of the material to be applied. With the calibration pan in place, push or pull the spreader by hand or power-driven vehicle over terrain typical of that to be treated for a sufficient distance to cover 0.01 acre, or 435.6 sq. ft. For a spreader 3 ft. wide, the distance should be $\frac{435.6}{3} = 145.2$ ft. For a spreader 8 ft. wide, the distance would be $\frac{435.6}{8} = 54.45$ ft.
2. Weigh the material from the calibration pan and multiply by 100 to give the amount applied per acre.
3. Continue this procedure with adjustments of the feed mechanism until the desired rate is achieved.

Hand Broadcasting and Mechanical Devices Not Equipped to Catch Herbicide

Begin with a weighed amount of herbicide formulation. Apply the material to a measured area, preferably 435.6 sq. ft., or 0.01 acre. Weigh the remaining material and subtract from the initial weight to determine how much was applied. Continue the procedure with appropriate adjustments until the desired rate can be approximated in repeated trials. Periodic recalibration is recommended. If the treatment period extends over several hours or days, occasionally check the rate being applied by weighing the amount applied to a measured area and make any necessary corrective adjustments.

EFFECT OF WEATHER CONDITIONS ON HERBICIDE APPLICATIONS

Wind

Winds cause improper distribution of herbicides and greatly increase the hazard of damage from drift to sensitive crops in nearby fields or gardens. Ground applications of herbicides seldom should be made during winds of more than 10 to 15 miles per hour. Applications by airplane should stop when winds become stronger than 6 to 8 miles per hour.

The herbicide 2,4-D and other phenoxy herbicides should never be applied when wind of any velocity is blowing across the area to be sprayed toward nearby valuable sensitive plants.

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3.10

Humidity

High or moderate humidity increases the effectiveness of most herbicide applications to foliage, because it reduces losses of spray by evaporation and aids absorption of the chemicals by weed foliage. Low humidity, on the other hand, reduces the effectiveness of herbicide sprays by increasing the rate of evaporation. The disadvantages of low humidity can be partly overcome by using oil or oil-water emulsions instead of water as spray diluents.

Temperature

Moderate temperatures, ranging from 70° to 85° F., are favorable for spray applications of most herbicides. Low temperatures during the week before spraying often slow plant growth and retard herbicidal activity. High temperatures increase losses of herbicides that are volatile and increase the possibility of injury to crops from selective herbicides. The carbamates, dinitro compounds and high-volatile esters of phenoxy compounds volatilize rapidly at temperatures above 80°. At temperatures above 90°, even the low-volatile esters of 2,4-D and other phenoxy compounds become significantly volatile. In general, do not use herbicidal sprays when the temperature is above 90°. Water temperature has a strong influence on the effectiveness of aquatic herbicides. Poor herbicidal activity can be anticipated at temperatures of 60° F or lower. Herbicides such as acrolein and xylene perform poorly at high water temperatures due to rapid losses by volatility.

Rainfall

Rainfall immediately after postemergence foliage applications of herbicides may reduce the effectiveness of the amine salt formulations of 2,4-D, water-soluble dinitro compounds, and some other foliage toxicants. Usually effectiveness is not reduced if a moderate rain occurs several hours after post-emergence application. The effectiveness of preemergence herbicide treatments may be increased by moderate rain occurring shortly after application. In low rainfall areas sprinkler irrigation is often used with good results when the water is applied immediately after preemergence herbicide applications. However, if heavy rains occur soon after preemergence treatments, control of weeds may be reduced or crop damage increased.

The variability in water quality and chemistry that occurs during the season affects the response of aquatic weeds to herbicides and the chemical and physical stability of herbicides in water. Salinity and alkalinity are among the more variable and important characteristics. Calcareous deposits on the surfaces of aquatic weeds reduce greatly their susceptibility to herbicides. Water pH influences the ionization state of many herbicides and the formation of salts and complexes that frequently are less reactive and less soluble in water.

USING THE HANDBOOK

The treatments for each crop are in alphabetical order. They are numbered as a convenient means of reference in discussion and revision. Choice of treatment to be used on specific weed problems can often be made by consulting the

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list of weeds killed by the various herbicides. This list is located in the Appendix.

Only a single treatment should be used on a crop planting unless specific additional treatments are indicated on the label.

Adjuvants such as surfactants, sequestering agents, oils, and others should only be used as described on the label.

The handbook is intended for use by knowledgeable State, Federal, and industry agricultural specialists. When in doubt about correct procedures for safe and effective weed control methods, consult local weed research or extension specialists. The labels are based on research conducted by State and Federal weed specialists in cooperation with industry.

Certain herbicides and some uses have been omitted because of limited use or specialized herbicidal capabilities.

WEED CONTROL IN AGRONOMIC CROPS

In the United States field crops are produced under diverse environments. Rainfall may vary from almost none to well over 75 inches. Performance of herbicides in crops that are furrow irrigated, or in rice which grows in flooded soil, for example, may be quite different than in those dependent on natural precipitation. Soil type, as well as the organic matter content of a specific soil, tremendously influences the responses of agronomic crops and weeds to herbicides. In view of the overall complexity of the various soil and cropping situations, the information in this section is intended only for general guidance and not for specific recommendations. Extension, university or industry specialists can supply detailed recommendations to fit local problems.

Herbicides are very effective tools for controlling weeds in agronomic crops. However, they must be used with discretion and care within prescribed rate ranges. In general, use only as much herbicide as is needed to control satisfactorily the weeds in a given situation. To use more than is recommended or more than is needed for a particular problem is wasteful and may contribute to crop injury and to lingering and possibly harmful residues in the soil.

In this era of fast changing technology one may be prone to overlook cultivation, a simple and often effective means of weed control. Cultivation fits some crops better than others. For example, in soybean production, if the first flush or two of weeds is removed by rotary hoeing, no further effort to control weeds will be needed. However, in growing peanuts, cultivation must be used with extreme care lest it set the stage for conditions conducive to the development of the southern blight disease.

Most crops compete effectively with weeds after reaching a certain stage of growth. Cotton or soybeans, for example, maintained weed-free for about 6 weeks, will then suppress most weeds for the remainder of the season if vigorous growth of the crop is maintained. Narrow spacings between rows and thick stands of the crop may further increase its competitive capacity. An increasing body of data from weed competition experiments is permitting more complete delineation of; (a) the period of essentially weed-free maintenance required for optimum yields; and (b) the periods where weed competition is most damaging. Generally, control of the first flush of weeds is the most critical.

See list of metric equivalents for weight, volume, area, and linear dimensions in the appendix.

Revised
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CORE LIST

Alfalfa

REPLACEMENT PAGES
FOR AH-447

Weeds in alfalfa are controlled by combining various practices. Crop management practices that permit good stand establishment and rapid growth of plants are important for controlling dodder. Alfalfa plants 2 ft. tall shade the ground and reduce infestations of dodder; use of herbicides and cultivation is important for controlling dodder during the early season. Frequent, shallow cultivation with appropriate tools in early spring and in the stubble after harvest kills dodder seedlings. Management of irrigation to permit drying of soil whenever feasible during the growing and harvesting seasons also controls dodder seedlings. Dodder plants attached to stubble alfalfa can be killed by spot flaming twice at 3-day intervals. This practice is helpful in alfalfa grown for seed if dodder infestations are spotty. Weeds not controlled by cultural and cultivation methods can be controlled effectively by use of herbicides.

PROBLEM: Dodder in established alfalfa

TREATMENT:

No. 1: Chlorpropham, 6 lb./A applied to moist soil before dodder attaches to the host in the spring. Remarks: Use granules. Supplement herbicide treatment with flaming and cultivation.

No. 2: Dichlobenil, 2 lb./A applied just before or after irrigation and before dodder attached to host. Remarks: Supplement herbicide treatment with flaming and cultivation for full-season control. Controls many other weeds. Use limited to Northwest. Use only on crop grown for seed.

No. 3: Pronamide, 1.5 lb./A applied in late winter or early spring before dodder germinates. Apply 120 days before harvest or grazing. Use limited to California, Idaho, Nevada, Oregon, and Washington. Do not graze treated fields or feed crop residues or clippings to livestock.

PROBLEM: Dodder in newly seeded alfalfa

TREATMENT:

No. 1: Chlorpropham, 5 lb./A applied after seedlings have first pair of true leaves. Remarks: Apply granules to moist soil before dodder attaches to host. Plant crop early so it reaches safe stage before dodder emerges. Treatment may stunt crop.

PROBLEM: Annual weeds in established alfalfa

TREATMENT:

No. 1: Dichlobenil, 2 lb./A. Remarks: Apply granules on alfalfa grown for seed only, just before or after irrigation. Use limited to Northwest. Do not graze or feed seeds or forage.

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- No. 2: Diuron, 1.5 to 3.2 lb./A, curing semidormancy or dormancy to crop established 1 year. Treated areas should not be planted to any crop for 2 years after treatment.
- No. 3: Simazine, 0.8 to 1.6 lb./A, applied to crop established at least 1 year, in early to mid-winter. Apply 30 days before grazing and 60 days before harvest.
- No. 4: Trifluralin, 0.5 to 0.75 lb./A applied to dormant alfalfa in late winter or early spring and incorporate to depth of 1 inch in the soil.
- No. 5: Dinoseb, 1.9 lb./A applied after first hay crop is removed but before regrowth starts and when weed seedlings are small. Remarks: Mix herbicide with 20 to 50 gallons of diesel or weed oil plus 50 to 100 gallons of water. Do not graze treated areas or cut hay for 60 days after treatment. This treatment usually used for seed production only.
- No. 6: MCPA, 0.5 lb./A applied for control of winter annual broadleaf weeds. Remarks: All alfalfa foliage must be completely killed by frost before application or crop injury will occur.
- No. 7: Propham, 4 lb./A applied in fall or winter for control of downy brome. Remarks: Propham may be combined with dinoseb for control of both broadleaf weeds and downy brome.

PROBLEM: Annual weeds in newly seeded alfalfa

TREATMENT:

- No. 1: EPTC, 2 to 4 lb./A incorporated in soil immediately before planting.
- No. 2: Benefin, 0.5 to 1 lb./A incorporated in soil immediately before planting.
- No. 3: 2,4-DB, 1 to 2 lb./A applied postemergence when weeds are less than 3 inches tall for control of broadleaf weeds. Remarks: 2,4-DB may be applied following EPTC or benefin to control broadleaf weeds that survive the soil-applied herbicide. As the alfalfa increases in age it becomes more susceptible to 2,4-DB. Apply at least 60 days before grazing or harvesting.
- No. 4: Dinoseb (ethanol and isopropanol amine salts), 0.75 to 1.5 lb./A applied postemergence when crop has two or more true leaves and when weeds are small. Remarks: Do not graze treated areas before first cutting or cut hay for 60 days after treatment.

PROBLEM: Perennial weeds in established alfalfa

TREATMENT:

- No. 1: Pronamide, 0.5 to 1.5 lb./A applied from fall to late winter for
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control of certain perennial grasses such as quackgrass and bermudagrass. Apply 120 days before harvest or grazing.

No. 2: Dichlobenil, 2 lb./A applied as a granular during the growing season for suppression of certain perennial weeds such as Canada thistle, dandelion, quackgrass, etc., in alfalfa grown for seed production.

Barley, Oats, and Wheat

Small grain crops are grown in the United States under diverse conditions of climate, soil, and cropping system. Cultural and mechanical practices help to control weeds wherever these crops are grown. However, use of herbicides often are an important part of a successful weed control program.

Herbicide treatments are presented for specific weed problems for the different small grains grown in various cropping systems. Check State recommendations for specific practices for a local area. Read the label carefully!

PROBLEM: Annual weed grasses and broadleaf weeds in winter wheat.

TREATMENT:

No. 1: Diuron, 1.2 to 1.6 lb./A applied anytime after planting up to boot stage of the crop. Remarks: Use only in western Oregon and western Washington. Do not plant any other crop within 1 year after treatment.

No. 2: Diuron, 0.8 to 1.2 lb./A applied before April 10 when weeds are less than 4 in. tall. Remarks: Use only in eastern Oregon, Washington, and Idaho where annual precipitation is more than 16 in.

No. 3: Terbutryn, 1.2 to 2.2 lb./A applied postemergence after wheat has a well-developed crown root system. Remarks: Use only in Washington, Oregon, and Idaho. Do not plant any crop except winter wheat in treated area for 9 months.

PROBLEM: Wild oats in barley and wheat.

TREATMENT:

No. 1: Barban, 0.25 to 0.375 lb./A applied when wild oats are in 2-leaf stage, but before crop reaches 4-leaf stage. Do not graze treated fields until after harvest.

PROBLEM: Annual broadleaf weeds in fall or spring seeded small grains.

TREATMENT:

No. 1: Bromoxynil, 0.25 to 0.5 lb./A applied to seedling weeds when barley or wheat is in 2-leaf to boot stages. Remarks: Do not use on oats. Do not apply when crop is stressed from lack of moisture. Effective only on small weeds. Controls some weeds that are not controlled by 2,4-D or MCPA. Do not graze treated fields for 30 days after treatment.

No. 2: MCPA, 0.2 to 0.5 lb./A applied from 3- to 4-leaf stages to boot stage. Remarks: Oats more tolerant to MCPA than 2,4-D. Very effective on small weed seedlings that germinate early when crop is small.

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No. 3: 2,4-D, 0.25 to 1.0 lb./A applied after crop is well-tillered but before boot stage. Remarks: Wheat most tolerant to 2,4-D; oats least tolerant. Wheat may be treated shortly before harvest which helps to desiccate weeds, but treatment at this time is less desirable than earlier. Treatment with 2,4-D top-kills several perennial weeds. Do not graze or feed forage from treated fields until 2 weeks after application of herbicides.

PROBLEM: Corn cockle, cow cockle, dogfennel, smartweed, wild buckwheat, and many other broadleaf weeds in fall-seeded barley, oats, and wheat.

TREATMENT:

No. 1: Dicamba, 0.25 lb./A.

No. 2: Dicamba, 0.12 lb./A + 2,4-D, 0.25 lb./A.

No. 3: Dicamba, 0.06 lb./A + bromoxynil, 0.25 to 0.38 lb./A (wheat only).

Remarks for Treatments 1 through 3: Apply postemergence in spring after winter dormancy, but before joint stage of crop. Mixture controls mustards better than dicamba alone. Dicamba controls most broadleaf weeds susceptible to 2,4-D. Do not graze or harvest for dairy feed before crop matures.

PROBLEM: Corn cockle, cow cockle, dogfennel, smartweeds, wild buckwheat, and many other broadleaf weeds in spring-seeded oats and wheat.

TREATMENT:

No. 1: Dicamba, 0.12 lb./A.

No. 2: Dicamba, 0.12 lb./A + 2,4-D, 0.25 lb./A.

Remarks for Treatments 1 and 2: Apply in 2- to 5-leaf stages of wheat or oats. Mixture controls mustards better than dicamba alone. Dicamba controls most broadleaf weeds susceptible to 2,4-D.

PROBLEM: Mustard, yellow rocket, and other broadleaf weeds in barley and wheat undersown with legumes.

TREATMENT:

No. 1: MCPA, 0.12 to 0.25 lb./A.

Remarks for Treatment 1: Apply after crop is well tillered, usually 4 to 8 in. tall, but before boot stage. Use only where weed infestations are high enough to reduce grain yields or legume stands. Use lowest volume of spray and delivery pressure possible to reduce penetration of crop and weed canopy; this reduces injury to legumes. These rates frequently fail to control weeds effectively in Southern, Northwestern, and Western United States. Check with local weed control specialists before using higher rates.

Corn

Corn grows under a wide range of environmental conditions and on a variety of soil types. Rotary hoes (power and ground driven) and sweeps are used widely to remove weeds from young corn. Even deep rooted perennial weeds often can be effectively controlled by cultivation. Timely and precise cultivation remains a very important method for removing weeds from corn. Flaming also safely removes weeds from corn especially if used as a basally directed treatment after corn is 12 in. high. A large number of herbicide treatments are also available to use alone, sequentially, or in combination with the best cultivation techniques.

Corn is grown in rotation with many other field crops. It is also resistant to some herbicides which are toxic both to broadleaf weeds and to broadleaf crops. Many weeds not amenable to control in other crops can be selectively controlled by herbicides applied in corn. Maximum effort should be made to reduce weed infestations while corn is grown on the land. This practice helps reduce weed problems in corn and in the rotated crops.

PROBLEM: Quackgrass and many annual species of grasses and broadleaf weeds.

TREATMENT:

No. 1: Atrazine, 2 to 4 lb./A. incorporated 2 to 4 in. deep in fall preceding year of corn production (or as split application in fall and spring before planting). Remarks: Poor to fair control of panicum grasses.

No. 2: Dalapon, 9 lb./A. Remarks: Plow 3 days after application and plant 4 weeks after plowing. Also controls johnsongrass from rhizomes.

PROBLEM: Control for annual and some perennial weeds before corn is planted.

TREATMENT:

No. 1: Butylate, 3 to 4 lb./A, thoroughly incorporated 3 in. deep immediately before planting. Remarks: Corn planted more than 2 in. deep may be severely injured. Controls johnsongrass seedlings and nutsedge. Do not use on hybrid corn grown for seed. See label for other restrictions on use.

No. 2: Paraquat, 0.25 to 1 lb./A. Remarks: Use nonionic surfactant at 0.5 percent volume/volume (V/V) on weeds 1 to 6 in. high. Do not apply on peat, muck, or pure sand. Controls only emerged weeds.

PROBLEM: Control of many annual grasses and broadleaf weed species with herbicides applied on the soil surface after planting but before crop emergence.

TREATMENT:

No. 1: Atrazine, 1.5 to 4 lb./A.

No. 2: Alachlor, 2 to 3 lb./A.

No. 3: Chloramben, 2 lb./A.

No. 4: CDAA 4 to 5 lb./A.

No. 5: Chlorbromuron, 2 to 4 lb./A.

No. 6: Cyanazine, 1.5 to 4 lb./A.

No. 7: Dinoseb, 7.5 to 9 lb./A.

No. 8: Linuron, 1 to 3 lb./A.

No. 9: Propachlor, 4 to 6 lb./A.

No. 10: Simazine, 1.5 to 4 lb./A.

No. 11: 2,4-D, 1 to 2 lb./A.

Remarks for Treatments 1 through 11: Some herbicides for corn are registered for use as mixtures; consult the various labels for details. Chloramben, 2,4-D, and linuron should not be applied on sandy soils. Chlorbromuron controls weeds poorly on soils containing more than 4 percent organic matter. Consult label for other restrictions and details involving use of these herbicides.

PROBLEM: Control of annual broadleaf weeds and grasses with herbicides applied as early postemergence treatments.

TREATMENT:

No. 1: Atrazine, 2 to 4 lb./A applied as overall spray within 3 weeks after planting. Remarks: Add surfactant to spray solution as specified on herbicide label. Weeds over 1 in. tall may not be controlled.

No. 2: Atrazine, 1 to 3 lb./A plus 1 to 2 gal./A of phytobland oil with emulsifier as overall spray to foliage of weeds and crops within 3 weeks after planting.

No. 3: Cyprazine, 1 lb./A, overall spray on corn less than 10 in. tall and weeds less than 4 in. tall. Remarks: Injury may occur if corn was previously treated with herbicides.

No. 4: Dinoseb, 3 to 4.5 lb./A as overall spray. Remarks: See label for use restrictions. Apply only when corn is in tight roll and before 2-leaf stage.

No. 5: 2,4-D at 0.25 to 0.50 lb./A as an overall spray to foliage of weeds and crop from emergence but before corn is 10 in. tall. Remarks: Use top rates in range only when necessary for control of hard-to-kill weeds.

No. 5: 2,4-D at 0.25 to 0.50 lb./A as an overall spray to foliage of weeds and crop from emergence but before corn is 10 in. tall. Remarks: Use top rates in range only when necessary for control of hard-to-kill weeds.

Avoid spraying when temperatures are above 85° F. Does not control grasses, but may temporarily inhibit growth of some broad-leaf perennial weeds. On taller corn, use drop nozzle to direct the spray toward the base of corn plants (see next treatment).

PROBLEM: Annual weeds after corn is 12 in. tall using sprays directed toward the base of the corn plants.

TREATMENT:

No. 1: Ametryn, 0.5 to 2.0 lb./A.

No. 2: 2,4-D, 0.25 to 0.5 lb./A. Remarks: Avoid spraying into whorl and upper leaves. Do not apply from tasseling through early dough stages. Some perennial broadleaf weeds will not be killed but may be suppressed.

No. 3: Linuron, 0.5 to 2.0 lb./A.

Remarks for Treatments 2 and 3: Apply as basally directed post-emergence spray to corn 15 to 30 in. high and on weeds less than 6 in. tall. Direct spray to strike corn no higher than 6 to 8 in. above soil level. Add 1 pt. of surfactant to each 25 gal. of spray mixture. Consult label for use restrictions.

No. 4: Atrazine, 1.0 lb./A. Remarks: Basally directed spray when corn is 20 to 30 in. tall on weeds not over 1 in. tall. Direct spray so as to avoid spraying the corn at points above one-third of its height. Add 1 pt. of surfactant to each 25 gal. of spray mixture. Do not plant treated areas to any crops except corn or sorghum until the following year.

No. 5: Dicamba, 0.12 to 0.25 lb./A. Remarks: May be sprayed over-the-top of crop until it is 8 in. tall; apply as a basally directed spray in corn 8 in. to 3 ft. tall. Does not control grasses. Soybeans are very susceptible to injury from spray drift from cornfield.

PROBLEM: Annual weeds with combination nitrogen solution and herbicide when corn is 20 to 30 in. tall.

TREATMENT:

No. 1: Appropriate nitrogen solution, 80 to 120 lb./A combined with one of the following herbicides:

(a) Atrazine, 1.0 to 2.0 lb./A

(b) Ametryn, 0.5 to 1.5 lb./A

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- (c) Diuron, 0.6 lb./A
- (d) Linuron, 0.5 to 1.5 lb./A
- (e) 2,4-D, 0.25 to 0.5 lb./A

Remarks: Direct the spray so as to avoid contact with crop at points over 3 to 4 in. above soil line. Add 0.5% V/V surfactant to spray solution. Good coverage of weeds is essential. Annual weeds less than 3 in. tall are more susceptible than taller weeds. Carefully examine herbicide labels for any use restrictions including crops grown subsequently.

Cotton

Many factors must be integrated with weed control to successfully produce a profitable crop of cotton. For example, various techniques of seedbed preparation and planting procedures are used to provide a soil surface that permits application of either early directed postemergence treatments or precision cultivation. Even treatment of cotton seed with a fungicide bears directly on weed control later in the season. Cotton sometimes emerges and grows slowly but a good fungicide usually leads to quick and uniform emergence of vigorous seedlings. Vigorous early growth of cotton will produce a canopy of leaves which will effectively shade out most weeds that emerge after cotton is 6 weeks old. This competitive capacity, if properly utilized, will enhance and supplement all other weed control procedures.

Historically, cultivation techniques formed the keystone of a weed control program in cotton. These techniques are still very important. Almost all annual weeds growing between the rows can be removed (from the time cotton emerges until it is 18 in. tall) with tools such as shallow running sweeps. Even most small weeds within the row can be uprooted with various devices set to cross-cultivate. This controls many weeds now resistant to herbicides.

Treatment with flame effectively controls weeds in the row and between rows. Addition of water shields to the burners permits flaming cotton as short as 5 in. Although designed primarily for small weeds, a series of precisely timed light flamings can slowly burn back large grass plants. For the many details and precautions involved in flaming for weed control, consult your local weed control specialists.

The era of hoeing all weeds from cotton is gone because of labor scarcity and other factors. However, this very effective method is still used on a spot basis to remove weeds that are resistant to all other control measures.

In most situations, combination programs using both cultural techniques and herbicides produce the best results for controlling weeds in cotton.

PROBLEM: Preplant control for emerged annual and some perennial weeds on seedbeds where cotton planting is delayed.

TREATMENT:

No. 1: MSMA, 2.0 lb./A. Remarks: Do not graze or feed forage from treated areas to livestock.

No. 2: Paraquat, 0.5 to 1.0 lb./A. Remarks: Use 0.5 pt. of nonionic surfactant per 100 gal. of solution. Avoid spray drift on desirable vegetation. Flush spray equipment with water after use each day because paraquat may be corrosive.

PROBLEM: Johnsongrass from seed, nutsedges, and many annual weeds.

TREATMENT:

No. 1: EPTC, 1.0 to 1.5 lb./A in subsurface bands or injected into the soil to a depth of 1 to 3 in. in lines that are 3 in. apart in conjunction with planting only. Remarks: Subsurface blades or injectors should be spaced so that no EPTC is applied within 4 in. of the drill row. This treatment with EPTC should be used in combination with a pre-planting application of trifluralin or a preemergence application of some other herbicide in the drill row where no EPTC is applied. Also, this treatment should be followed by postemergence treatments with either naphtha, DMA, or other herbicides. Special instructions for triband weed control are essential to successful use of this practice. The treatment may be injurious to cotton under the furrow-irrigation systems of the Western United States.

PROBLEM: Emerged nutsedge, small johnsongrass, and many annual weeds.

TREATMENT:

No. 1: Naphtha or petroleum solvents, 20 gal./A of 10 in. band actually treated (equivalent to 5 gal./A if cotton rows are 40 in. apart). Remarks: Apply as a basally directed spray to weed foliage after smallest cotton is 2 in. tall, but before bark cracks appear on the cotton stem (from about 1 to 4 weeks after emergence). Direct spray to avoid contact with cotyledonary and true leaves of the crop. Diseased or mechanically damaged cotton may be severely injured. Naphtha not developed for cotton may be satisfactory. Usually ineffective on weeds more than 2 to 3 in. tall, although some species of grasses and nutsedge may be controlled even though they are taller.

No. 2: Emulsified herbicidal oil in a 1:1 ratio with water. Remarks: Apply as a basally directed spray on small weeds, one to four times with at least 1 week between applications. Begin treatments after cotton is 3 in. tall. Use same volume per acre and application precautions as for Treatment No. 1. Treat only healthy cotton. Pour oil into tank with agitator started then add volume of water to satisfy ratio requirements. When oil slick disappears, the emulsion is ready to spray. Agitate continuously.

No. 3: DSMA, 3.0 lb./A or MSMA 2.0 lb./A. Remarks: One or two applications after smallest cotton is at least 3 in. tall but before first bloom opens. When spraying cotton 3 to 4 in. tall, minimize contact between cotton foliage and spray. Do not spray growing point of cotton. On taller cotton, direct spray to avoid spraying the crop at points above 2 or 3 in. from the soil line. Normally, use 1 pt. of surfactant for each 25 gal. of spray mixture. Treatment appears more effective during hot, dry periods than in cool, moist weather.

PROBLEM: Annual grasses and some small-seeded broadleaf weeds with preplant soil incorporated treatments.

TREATMENT:

No. 1: DCPA, 8.0 to 10.5 lb./A.

No. 2: Nitralin, 0.5 to 1.0 lb./A.

No. 3: Dinitramine, 0.33 to 0.66 lb./A.

No. 4: Trifluralin, 0.5 to 1.0 lb./A.

Remarks for Treatments 1 through 4: Incorporate immediately after application. Mix uniformly 1 to 2 in. deep. Incorporation should be done after seedbeds are in final form or final preparation of seedbeds should be by a method that keeps herbicide in position no deeper than 1 in. below point at which cotton seeds are to be planted.

No. 5: Nitralin, 1.25 lb./A.

No. 6: Trifluralin, 0.75 to 1.25 lb./A.

Remarks for Treatments 5 and 6: For fall treatment only. See manufacturer's label for rate limitations on various soil types and sensitivity of crops planted after cotton. Do not apply on land subject either to flooding or to prolonged periods in a waterlogged condition.

No. 7: Diuron, 0.8 to 1.6 lb./A. Remarks: In Arizona and California only, broadcast spray over preformed irrigated beds just before planting. Soil from tops of beds to be removed while planting but returned by postemergence cultivation. See manufacturer's label for restrictions on soil types and other limitations. This treatment usually preceded by applications of either trifluralin or nitralin.

PROBLEM: Small-seeded annual weeds after planting but before emergence of weeds or crop.

No. 1: DCPA, 7.0 to 9.0 lb./A.

No. 2: Diuron, 0.4 to 1.6 lb./A.

No. 3: Fluometuron, 0.75 to 2.0 lb./A. Remarks: Do not feed treated foliage or give trash to livestock.

No. 4: Prometryne, 1.0 to 2.4 lb./A. Remarks: Use restricted to California and Arizona. Do not graze or feed storage from treated areas to livestock.

Remarks for Treatments 1 through 4: Normally applied in conjunction with planting; however, usually ineffective in Arizona and California because of limited rainfall.

To make the treatment less dependent on weather conditions add fluometuron at 0.8 lb./A. After the cotton is 6 in. tall, but before first bloom add either diuron at 0.2 lb./A or prometryne at 0.6 lb.A.

PROBLEM: Most young and actively growing annual weeds after cotton is 6 in. tall.

TREATMENT:

- No. 1: Diuron, 0.2 to 0.4 lb./A. Remarks: Usually two basally directed applications will be needed for effective control. Add 1 pt. of surfactant for each 25 gal. of spray mixture. Poor control will usually result under dry conditions.
- No. 2: Fluometuron at 1.25 to 2.0 lb./A. Remarks: Basally directed treatment for irrigated areas in the West. Use before weeds emerge. See label for details of registered use. If surfactant is added, rate range of fluometuron can be reduced to 0.8 to 1.25 lb./A.
- No. 3: Trifluralin, 0.5 to 0.75 lb./A, as basally directed spray immediately before the first postemergence irrigation in the western irrigated Cotton Belt only. Remarks: Apply to weed-free soil between rows and incorporate immediately to depth of 1 to 2 in.

PROBLEM: Most young and actively growing weeds after cotton is 12 in. tall or at layby.

TREATMENT:

- No. 1: Diuron, 0.3 to 0.75 lb./A, applied as a basally directed spray when cotton is 12 in. tall and again when 14 to 25 in. tall. Remarks: Add 1 pt. of surfactant for each 25 gal. of spray mixture. Normally, do not cultivate after the first application, and for this reason, split application is not suggested where resistant weeds are present.
- No. 2: Diuron, 0.5 to 1.5 lb./A, applied as a basally directed spray to the soil surface and foliage of emerged weeds.

Remarks for Treatments 1 and 2: Add 1.0 pt. of surfactant for each 25 gal. of spray mixture if emerged weeds are present. In irrigated areas, water management is essential to insure thorough wetting of beds after application.

- No. 3: Prometryne, 0.8 to 1.6 lb./A. Remarks: Use as directed spray at layby. Do not graze or feed forage from treated areas to livestock.
- No. 4: Trifluralin, 0.75 to 1.0 lb./A.

Remarks for Treatments 3 and 4: See label for special instructions and limitations for use in irrigated areas of the West.

PROBLEM: Most weeds less than 3 in. high when cotton is ready to layby (15 to 25 in. high)

TREATMENT:

No. 1: Diuron at 0.5 to 1.5 lb./A.

No. 2: Linuron at 0.5 to 1.5 lb./A.

No. 3: Prometryne at 1.0 lb./A. Remarks: Do not graze or feed forage from treated areas to livestock.

Remarks for Treatments 1 through 3: Add 1.0 pt. of surfactant for each 25 gal. of spray mixture if emerged weeds are present. In irrigated areas, water management is essential to insure thorough wetting of beds after application. See label for special limitations applicable to Western States and for restrictions on crops to be planted in treated soils.

PROBLEM: Johnsongrass

TREATMENT:

No. 1: Dalapon, mixed in a concentration of 0.74 lb. per 10 gal. of water, applied as a spot treatment where infestation of target weeds is less than 5 percent. Remarks: Dalapon should be applied to wet all foliage but runoff into soil should be avoided. Cotton sprayed with dalapon may be injured.

No. 2: Oil soluble ester of TCA, mixed in a concentration of 1.0 lb. of TCA per 5 gal. of diesel fuel and applied as a spot treatment. Remarks: Apply TCA to wet the lower 4 to 6 in. of all johnsongrass. The rate may be reduced by 50 percent if the grass is not taller than 12 in. and all of the leaves are sprayed. Spot treatment is seldom economical if infestation exceeds 5 percent. Cotton sprayed with TCA ester may be injured.

PROBLEM: Emerged grasses

TREATMENT:

No. 1: Geese, 3 to 5 birds per acre. Remarks: Used most commonly in irrigated areas of California. Requires detailed management, such as confinement to field, clean drinking water and supplemental feeding daily, movable shade, moving of drinking and feeding sites, protection from weather, dogs, other predators, and chemicals.

General remarks for all problems: Many herbicides used for controlling weeds in cotton, especially those used as postemergence treatments, are registered for application as tank mixtures. Because of the numerous treatments involved, and also due to certain geographical restrictions, we did not attempt to list all registered mixtures of herbicides. In addition, sequential herbicide

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treatments are cutomarily used. See the respective manufacturers' label and local weed control specialists for further information on mixtures of herbicides and sequential treatment combinations.

Established Grasses and Forage Legumes Grown For Seed

Cultivation and flaming combined with herbicides control many weeds effectively in established grasses and legumes grown for seed. Planting grass crops in rows followed by timely postemergence sweep cultivation controls annual weeds effectively. However, heavy rains frequently prevent use of timely and repeated cultivations; this occurs where winter annual weeds infest fields during wet periods. Flaming grass and legume crops controls most annual weeds. This practice can be used before seeding grass and legume crops, during the interval between hay and seed production, and while crops are in dormant stages of growth.

Where cultivation and flaming fail to control weeds effectively, herbicides may be used to good advantage. Performance of herbicides is affected by soil and climate. Herbicides must be applied at precise rates and times for specific weeds in various cropping systems. Precise information on the use of herbicides in grass and legume crops can be obtained from local weed control specialists.

PROBLEM: Downy brome in established grasses grown for seed

TREATMENT:

No. 1: Dicamba, 2.0 to 3.0 lb./A.

No. 2: Protham, 4.0 lb./A.

Remarks for Treatments 1 and 2: Apply soon after first postharvest irrigation. Remove all crop residues by burning or by mechanical means immediately after harvest and before application. Use dicamba only in eastern Oregon and protham only in eastern Washington. See label for limitations and restrictions.

PROBLEM: Annual broadleaf weeds in established grasses grown for seed

TREATMENT:

No. 1: Dicamba, 0.25 to 0.5 lb./A.

No. 2: MCPA, 0.5 to 0.75 lb./A.

No. 3: 2,4-D, 0.5 to 0.75 lb./A.

Remarks for Treatments 1 through 3: Apply after seedling crop grasses have three to five leaves. Treat established crop grasses up to boot stage; can be retreated after harvest; do not treat from boot stage until harvest. Small actively growing weeds are most susceptible to treatments. Use higher rates only on well established stands. See label for limitations and restrictions.

No. 4: Bromoxynil, 0.38 to 0.5 lb./A applied after crop grasses emerge but before weeds have three to four leaves. Remarks: Do not graze fields or feed crop threshings to livestock. Herbicide is toxic to fish and wildlife. Do not contaminate lakes, streams, or ponds.

PROBLEM: Winter annuals in established grasses grown for seed.

TREATMENT:

No. 1: Diuron, 1.0 to 2.3 lb./A. Do not replant to any other crop within 2 years.

No. 2: Atrazine, 1.0 to 1.12 lb./A.

No. 3: Simazine, 1.0 to 2.0 lb./A.

No. 4: Chlorpropham, 2.0 to 3.0 lb./A.

No. 5: Protham, 2.0 to 4.0 lb./A.

Remarks for Treatments 1 through 5: Remove all crop residues before application. Apply in the fall before weeds emerge or while seedlings are still very small. Diuron may be used on bentgrass (except Penneross) Kentucky bluegrass, orchardgrass, and tall fescue in western Oregon and on switchgrass, side oats gamma, and sand bluestem in Colorado, Kansas, New Mexico, and Oklahoma; it may be used on orchardgrass, tall fescue, and Kentucky bluegrass the first fall after spring plantings if the grasses are well established and growing vigorously. Do not apply treatments 2-5 until grasses are 1 year old or until after a seed crop has been harvested. Use atrazine only on perennial ryegrass grown in the Pacific Northwest. Apply treatments 3-5 to perennial ryegrass, Highland and Astoria bentgrass, fine leaf fescues, tall fescues, Kentucky bluegrass and orchardgrass in western Oregon. Apply protham to Kentucky bluegrass in eastern Washington and Oregon. Do not graze fields treated with atrazine within 10 days after treatment or with simazine within 30 days after treatment.

PROBLEM: Annual and perennial broadleaf weeds in established alfalfa, birds-foot trefoil, and clovers, including alsike, ladino, red, and white clover, grown for seed.

TREATMENT:

No. 1: 2,4-DB, 0.5 to 2.0 lb./A applied postemergence before crop legumes begin budding. Remarks: Treat weeds that are less than 3 in. tall; those less than 1 in. tall are most susceptible. Rapidly growing weeds are controlled best. Use higher rates only for established crop legumes. Do not use on lespedeza. May reduce seed yield of clovers and trefoil when applied in spring. Nonlegume weeds, that are susceptible to 2,4-D, are controlled by 2,4-DB. See label for limitations and restrictions.

PROBLEM: Desiccation before harvest of all weeds in established alfalfa, birdsfoot trefoil, and clovers, including alsike, ladino, red, and white clover, grown for seed.

TREATMENT:

No. 1: Dinoseb, 1.2 to 1.9 lb./A in 5 to 10 gal/A diesel oil.

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No. 2: Diquat, 0.75 to 1.0 lb./A in 20 to 40 gal/A water.

No. 3: Endothall, 1.0 to 5.75 lb./A in 5 to 10 gal/A water.

No. 4: PCP, 4.0 to 6.0 lb./A in 5 to 10 gal/A diesel oil.

Remarks for Treatments 1 through 4: Apply before harvest to desiccate weeds. Applications before crop-legume seed mature may reduce yield and quality since both crop and weeds are desiccated. Do not use dinoseb or diquat on lespedeza, or diquat on trefoil. Do not graze crop or feed treated forage to livestock.

PROBLEM: Winter annual weed grasses and some perennial weed grasses in established alfalfa and clovers grown for seed.

TREATMENT:

No. 1: Pronamide, 0.25 to 1.0 lb./A applied in fall or winter, but before soil freezes in cold areas and after crop legumes have trifoliate leaves. Remarks: Use only in California, Idaho, Nevada, Oregon, and Washington. Do not graze fields or feed crop threshings to livestock.

PROBLEM: Winter annual grasses and chickweed in established alfalfa, birdsfoot trefoil, and clovers, including crimson, ladino, red, subterranean, and white clover, grown for seed.

TREATMENT:

No. 1: Chlorpropham, 3.0 to 4.0 lb./A.

No. 2: Propham, 3.0 to 4.0 lb./A.

Remarks for Treatments 1 and 2: Apply in winter when crop legumes are dormant or semi-dormant, treat before weeds germinate and until small seedling stages. Treat only after legumes have several true leaves. Burn to remove crop residues before herbicide application to alfalfa or birdsfoot trefoil but clovers are severely damaged by burning.

PROBLEM: Broadleaf weeds in alfalfa and clovers, including crimson, ladino, red, subterranean, and white clover, grown for seed and interseeded with small grain crops.

TREATMENT:

No. 1: MCPA, 0.13 to 0.25 lb./A applied postemergence in early spring after weeds begin growing actively and after cereal crop tillers. Remarks: Apply after small grain crops form a canopy over small legume plants to reduce injury to legumes. Use only on new plantings of legume crops. Herbicide rates vary with species of legume, but do not use on birdsfoot trefoil. Do not graze dairy or meat animals on fields or feed crop threshings to livestock.

PROBLEM: Annual weeds in established birdsfoot trefoil grown for seed.

TREATMENT:

No. 1: Diuron, 1.6 lb./A applied before weeds germinate and until small seedling stages in winter when crop is dormant and semi-dormant.

Remarks: Burn or remove crop residues before application. Use restricted to Western Oregon.

Flax

Cultural and mechanical methods are important tools for controlling weeds in flax. Selecting fields relatively free of weeds and tilling land in late summer and early fall help control annual and perennial weeds. However, late summer and fall tillage increases soil erosion by wind and water. Tilling soil in the spring before planting reduces wild oat infestations. But this practice may delay planting the crop in the spring and reduce flax yields. If planting is delayed because of weed control inputs, the use of early-maturing varieties helps prevent losses in yield.

Where cultural and tillage practices fail to control weeds effectively, selected herbicides are useful for controlling weed infestations in flax. Combining practices into weed control systems usually controls weeds more effectively than single treatments used alone. Herbicides, therefore, are important tools in an effective weed control program.

PROBLEM: Wild oats

TREATMENT:

No. 1: Barban, 0.25 to 0.37 lb./A applied postemergence to wild oats with two leaves but before flax reaches 12-leaf stage. Remarks: Apply broadcast to weed foliage. Do not feed flax straw to livestock.

No. 2: Diallate, 1.5 to 2 lb./A incorporated in soil in the fall before seeding flax the following spring, or in spring before seeding flax.

PROBLEM: Broadleaf weeds

TREATMENT:

No. 1: MCPA, 0.1 to 0.6 lb./A applied postemergence to small weeds and when the crop is 2 to 6 in. tall. Remarks: Apply broadcast to weeds and crop foliage. Dalapon can be mixed with MCPA for control of both grass and broadleaf weeds.

No. 2: Bromoxynil, 0.25 to 0.5 lb./A applied to small weeds when the crop is 2 to 8 in. tall. Remarks: Apply broadcast to weeds and crop foliage. Primarily for the control of smartweeds and wild buckwheat. Do not graze for 30 days after treatment.

PROBLEM: Annual weed grasses

TREATMENT:

No. 1: EPTC, 3 lb./A incorporated in soil before planting flax. Remarks: May also control some broadleaf weeds.

No. 2: Dalapon, 0.75 lb./A applied to small weed-grass plants when crop is 2 to 6 in. tall. Remarks: Apply broadcast to weed and crop foliage. MCPA can be mixed with dalapon for control of both grass and broadleaf weeds.

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Peanuts

Cultivation practices, which deposit soil on peanut foliage or around the stems of peanut plants, often encourage severe infestations of southern blight (white mold or stem rot). This disease can reduce severely the yield of peanuts. Shallow cultivation, which moves no soil to the peanut plant, should be used. Recent research results indicate, however, that a cultivation properly done several weeks after planting is beneficial from the standpoint of weed control and crop yields. A common practice on farms is to use the herbicides best suited for the weed spectrum involved followed by one and possibly two shallow cultivations which do not deposit soil on or around the peanut plant.

Actually, both good weed control and disease prevention in peanuts begin with seedbed preparation. All litter should be buried at least 3 in. deep with a moldboard plow fitted with coulters. This operation also buries the weed seed in or near the soil surface. Non-dirting, flat sweeps are generally the most satisfactory tools for cultivating established peanuts. Beet knives are sometimes best for early cultivations near the row.

Some broadleaf weeds, such as bristly starbur and cocklebur are not controlled satisfactorily for any length of time by herbicides now registered for use in peanuts. Those which emerge with the peanuts can be controlled fairly well with a contact herbicide applied at "cracking." This early control can be supplemented by cultural means which include: (a) using high quality peanut seed to produce vigorous peanut seedlings. (b) thick stands to produce rapid shading in the row, (c) closely spaced rows to produce a canopy of foliage which will shade the middles between the rows, and (d) good management practices to maintain the canopy of leaves intact, thus shading the ground until harvest.

PROBLEM: Control of Texas panicum, most other annual grasses and many small-seeded broadleaf weeds with herbicides incorporated into the soil before planting.

TREATMENT:

No. 1: Benefin, 1.12 to 1.5 lb./A incorporated to a depth of 3 in. from 0 to 3 weeks before planting.

No. 2: Nitralin, 0.5 to 1 lb./A (depending on soil type) incorporated 1 to 1.5 in. deep from 0 to 3 weeks before planting.

No. 3: Trifluralin, 0.5 lb./A incorporated in soil to a depth of 1 to 1.5 in. from 0 to 3 weeks before planting Spanish peanuts in Oklahoma and Texas only.

Remarks for Treatments 1, 2, and 3: None of these treatments will adequately control bristly starbur, cocklebur, Florida beggarweed, morningglories, ragweed or sicklepod.

PROBLEM: Control of perennial nutsedges and many annual weeds.

TREATMENT:

- No. 1: Vernolate, 2 to 2.5 lb./A, incorporated to a depth of 3 in. from 0 to 3 weeks before planting, or injected in parallel lines (3 to 4 in. apart) to a depth of 3 in. simultaneously with planting. Remarks: For injection, the planters and injectors must operate as a single unit to insure that the crop seed will be centered between two parallel lines of herbicide. Generally, vernolate controls more weeds, controls them better and injures peanuts less when injected than when incorporated.
- No. 2: Vernolate, 2 lb./A plus benefin at 1.12 lb./A incorporated to a depth of 3 in. from 0 to 3 weeks before planting. Remarks: Better control of some annual grasses than with vernolate alone.

PROBLEM: Control of many species of annual grasses and small-seeded broadleaf weeds with herbicides applied after planting peanuts but before weeds emerge.

TREATMENT:

- No. 1: Alachlor, 2 to 4 lb./A.
- No. 2: Chloramben 2 to 3 lb./A (in Texas and Oklahoma only).
- No. 3: Dinoseb, 6 to 12 lb./A. Remarks: Although sometimes used alone as a preemergence treatment, dinoseb is more often used as a "cracking" time treatment alone or in combination with other herbicides. Dinoseb is more effective on weeds when the weather is warm or hot.
- No. 4: Diphenamid, 4 to 6 lb./A.
- No. 5: Naptalam, 4 to 6 lb./A.

PROBLEM: Control of many species of annual weeds at "cracking" (emergent stage of weeds and peanuts).

TREATMENT:

- No. 1: Dinoseb (ethanol and isopropanol amine salts) 3 to 6 lb./A.
- No. 2: Diphenamid, 2.0 lb./A + dinoseb, 1.5 lb./A.
- No. 3: Naptalam, 2 lb./A + dinoseb, 1 lb./A; or naptalam 3 lb./A + dinoseb, 2 lb./A.

Remarks for Treatments 1 through 3: For optimum weed control and crop tolerance, these treatments should be applied when peanuts are "cracking" the ground or when weeds are barely visible, whichever occurs first.

PROBLEM: Control of weeds that emerge after the "cracking" stage.

TREATMENT:

- No. 1: Dinoseb (ethanol and isopropanol amine salts) 3 lb./A. Remarks:
Must not be used after peanut foliage is more than 2 in. in diameter.
- No. 2: Dinoseb (ethanol and isopropanol amine salts) 1.5 lb./A applied as a shielded spray. Remarks: Shield the peanut plants to avoid contact with the spray. Effective only on newly emerged weeds. Must be used no later than 4 weeks after "cracking."

Rice

Rice in the United States is grown in flooded soil which stimulates growth of aquatic weeds, but retards germination and growth of upland weeds. Therefore, water management offers unusual opportunity to control specific weeds. For example, water-seeding rice combined with continuous flooding controls barnyard grass, but this seeding method stimulates germination of duckweed; redstem, waterhyssop, or other aquatic weeds. The use of effective herbicide treatments to control weeds that develop where water management practices fail is important in a weed control program.

Cultural and mechanical methods effectively control specific weeds in rice. Cropping systems that include row crops such as soybeans and grain sorghum in the rotation with rice reduce infestations of red rice and many grass, broad-leaf, aquatic, and sedge weeds. Use of effective herbicides in row crops rotated with rice not only controls weeds in the row-crop but reduces some weeds in the rice crop.

Effective weed control programs, therefore, combine preventive, cultural, mechanical, and chemical methods. When any one of these is omitted, weeds may not be controlled effectively.

PROBLEM: Barnyardgrass

TREATMENT:

- No. 1: Molinate, 3 lb./A applied during final seedbed preparation and immediately before flooding and seeding. Remarks: Use only in water-seeded rice. Incorporate emulsifiable or granular formulations 1 to 2 in. deep by cross-disking or flooding field immediately after application.
- No. 2: Molinate, 3 lb./A applied to grass in the one- to four-leaf stages. Remarks: Broadcast granules aerially to flooded rice. May be used on dry- or water-seeded rice. Maintain flood for at least 7 days; 14 days of residual control is obtained if drained at 7 days. Weeds on levees and unflooded areas are not controlled. Do not apply after rice internodes exceed 0.5 in.
- No. 3: Molinate, 3 lb./A applied to grasses 5 to 12 in. tall. Remarks: Apply into 4 to 6 in. of water and maintain flood. Suppresses growth of large grass plants.
- No. 4: Molinate, 3 lb./A metered into irrigation water when grass plants are less than 3 in. tall. Remarks: Treat areas inaccessible to aircraft and adjacent to crops susceptible to injury from drift. Poor weed control on levees and unflooded areas.
- No. 5: Propanil, 3 to 5 lb./A applied to grass in the one- to four-leaf stages. Remarks: Rice may be drill-, broadcast-, or water-seeded. Drain or lower water to expose weed foliage if rice is water-seeded. Apply in 10 to 15 gal./A of water for aircraft spraying or in 15 to

20 gal./A of water for ground spraying. Most effective on rapidly growing grass; if soil is dry control is improved by flushing field 2 to 3 days before spraying. Postpone spraying for warmer temperatures if below 50 F at night and below 70 F during day. Flooding may begin 24 hr. after application and complete in 2 to 4 days. Spray droplets 200 to 400 micron diameter are preferable to finer or coarser spray. Do not: (a) mix propanil with pesticides or fertilizers; (b) apply within 15 days before or after applying parathion or carbaryl, or anytime after applying carbofuron; or (c) apply after rice plant internodes elongate beyond 0.5 inch.

No. 6: Propanil, 5 to 6 lb./A when grass is in the tillering to jointing stages. Remarks: Broadcast aerially in 12 to 15 gal./A of spray mixture to flooded rice. Most effective on rapidly growing grass; if grass is growing slowly, a light application of nitrogen in the flood 4 to 7 days before applying propanil stimulates grass growth. See treatment 3 for application instructions and precautions.

No. 7: Propanil, 3 lb./A applied early to grass with one to two leaves followed by 3 lb./A after more grasses emerge and when the largest plants have three leaves. Remarks: Especially effective where flood is not maintained after treatment, e.g., on calcareous (alkaline) soil. See treatment 3 under barnyardgrass problem for application instructions and precautions.

PROBLEM: Broadleaf signalgrass, annual spikerush, annual flatsedge, and small annual broadleaf weeds.

TREATMENT:

No. 1: Propanil, 3 to 5 lb./A when weeds are less than 4 in. tall. Remarks: See treatment 3 under barnyardgrass problem for application instructions and precautions.

PROBLEM: Tighthead sprangletop, smartweed, morningglory, and volunteer sorghum.

TREATMENT:

No. 1: Propanil, 3 lb./A early to weeds less than 2 in. tall followed by 3 lb./A 5 to 7 days later. Remarks: Apply aerially in 10 gal./A spray mixture at each time. See treatment 3 under barnyardgrass problem for application instructions and precautions.

PROBLEM: Bearded, Mexican and red sprangletop.

TREATMENT:

No. 1: Propanil 5 to 6 lb./A applied to grass in the one- to three-leaf stages when weeds are less than 0.5 in. tall. Remarks: See treatment 3 under barnyardgrass problem for application instructions and precautions.

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No. 2: Propanil 3 lb./A + molinate 2 to 3 lb./A applied to weeds 0.5 in. tall or less. Remarks: Apply in a tank mixture in a total spray of 10 gpa by airplane when weeds are growing rapidly. Apply to drained but wet fields; flood field within 5 days after treatment.

PROBLEM: Aquatic, broadleaf and sedge weeds including ducksalad, mudplantain, redstem, purple ammannia, waterhyssop, gooseweed, false pimpernel, spikerush, and annual flatsedge at early-season period.

TREATMENT:

No. 1: Propanil, 3 lb./A applied to weeds less than 1 inch tall. Remarks: Apply aerially immediately after draining rice field. See treatment 3 under barnyardgrass problem for application instructions and precautions.

No. 2: Silvex, 0.5 to 1.0 lb./A when weeds are less than 4 in. tall and 3 to 6 weeks after rice emergence. Remarks: Drain field before treatment. Apply aerially in 5 gal./A of spray mixture.

No. 3: Silvex LV ester, 0.25 to 0.5 lb./A applied 3 to 6 weeks after rice emergence and to weeds less than 4 in. tall. Remarks: Apply aerially in recommended quantity of nitrogen solution. Do not apply more than 5 gpa nitrogen solution on soil not requiring nitrogen at time of herbicide treatment.

PROBLEM: Arrowhead, ducksalad, false pimpernel, fimbristylis, flatsedge, gooseweed, Mexican weed, mudplantain, purple ammannia, redstem, smartweed, spikerush, waterhyacinth, waterhyssop, and waterprimrose at midseason period.

TREATMENT:

No. 1: MCPA, 0.5 to 1.5 lb./A.

No. 2: Silvex, 0.5 to 1.5 lb./A.

No. 3: 2,4-D, 0.5 to 1.5 lb./A.

Remarks for Treatments 1 to 3: Apply when rice internodes are 0.1 to 0.5 in. long. Lower water level to expose weeds to herbicide. Apply aerially in 5 gal./A of spray mixture only when temperature ranges from 70 to 90 F. Rain within 1 to 6 hours after treatment may reduce effectiveness.

PROBLEM: Submersed aquatics including American pondweed, horned pondweed, and naiad; emerged aquatics including burhead, California arrowhead, common water plantain, and narrowleaf cattail; and sedges including largespiked spikerush, roughseed bulrush, and smallflower umbrellaplant.

TREATMENT:

No. 1: MCPA, 0.75 to 1.5 lb./A.

No. 2: 2,4-D, 0.75 to 1.5 lb./A.

Remarks for Treatments 1 and 2: Apply aerially in 5 gpa at midseason when rice internodes are 0.25 in. long, but do not apply after internodes are more than 0.5 in. long. If treatments are required because of heavy weed growth before rice internodes are 0.25 in. long use MCPA instead of 2,4-D. MCPA injures rice less than 2,4-D when applied at any stage of rice growth. Use lower scale of rate when air temperature is above 90 F. Submersed weeds should be floating on water surface and emerged weeds should be well above water surface for exposure to the spray.

PROBLEM: Sesbania

TREATMENT:

No. 1: Propanil, 3 lb./A applied to weeds 0.5 to 5 feet tall. Remarks: Do not apply after rice internodes are 0.5 in. long. See treatment 3 under barnyardgrass problem for application instructions and precautions.

No. 2: Silvex, 0.5 to 1 lb./A applied to weeds after rice is 3 weeks old and up to time internodes are 0.5 in. long.

No. 3: 2,4-D, 0.5 to 1 lb./A applied to weeds after first elongating internode begin movement and up to 0.5 in. long. Remarks: Do not apply when internode exceeds 0.5 in.; shallow flood field before application.

PROBLEM: Northern jointvetch

TREATMENT:

No. 1: Propanil, 3 lb./A applied to weeds less than 1 foot tall. Remarks: Do not apply after rice internodes are beyond 0.5 in. long. See treatment 3 under barnyardgrass problem for application instructions and precautions.

No. 2: Silvex, 0.5 to 1.5 lb./A applied 3 weeks after rice emergence and up to time internodes are 0.5 in. long. Remarks: Do not apply when internode exceeds 0.5 in.; shallow flood field before application.

PROBLEM: Dayflower

TREATMENT:

No. 1: MCPA, 0.5 to 1.5 lb./A.

Safflower

PROBLEM: Many annual species of small-seeded grass and broadleaf weeds.

TREATMENT:

No. 1: EPTC, 3 lb./A incorporated in the top 2 to 3 in. of soil before planting the crop. Remarks: EPTC also controls nutsedge and volunteer small grains.

No. 2: Trifluralin, 0.75 to 1.0 lb./A incorporated in the top 2 in. of soil before planting the crop. Remarks: Controls weedgrasses better than broadleaf weeds.

Sorghum

Thorough seedbed preparation and cultivation before and after emergence of the crop help to control most weeds in sorghum. Shallow sweep cultivation controls seedling weeds and prevents excessive moisture loss. Timely rotary hoeing after sorghum plants are 2 in. tall (and up to the time stems stiffen) control shallow-rooted weed seedlings that are small enough to be uprooted.

In most fields infested with a combination of both annual grass and broadleaf weeds, best control will be obtained with a combination of good husbandry between crops along with the use of mechanical weed control and herbicides in the crop. In fields infested only with pigweed, herbicide treatment alone may give 100% control. Any weed control program should be flexible enough so that if a particular method fails a back up method can be utilized promptly.

PROBLEM: Many annual species of small-seeded weed grasses and broadleaf weeds.

TREATMENT:

No. 1: Atrazine, 1.0 to 3.0 lb/A applied to the soil surface after planting but before the crop emergence. **Remarks:** Apply to clay soils or other fine textured soils with more than 2% organic matter. Do not use on soils of coarse texture or low in organic matter. Plant crop 1 in. deep or deeper to reduce crop injury. Do not plant treated fields to any crop except corn or sorghum until one year after treatment.

No. 2: Linuron, 0.5 to 1.0 lb/A + propazine, 0.5 to 1.2 lb/A applied after planting but before crop emergence. **Remarks:** Do not plant to any crop not on label for 4 months after treatment.

No. 3: Propachlor, 2.3 to 3.6 lb/A + propazine, 0.8 + 1.25 lb/A applied after planting but before crop emergence.

Remarks for Treatments 2 and 3: Do not plant crops other than corn or sorghum for 18 months. Do not use on sandy or loamy sand soils. Do not graze or feed forage or silage from treated fields to dairy animals.

No. 4: Propazine, 1.2 to 2.5 lb./A applied before planting. **Remarks:** Incorporate in surface 2 to 3 in. of soil by disking or rotary cultivating; may be incorporated broadcast on unbedded land or into beds on a band on bedded land. Apply within 1 month of planting. In Arkansas, Louisiana, Texas, Gulf Coast, Texas Blacklands, fields may be planted to cotton, soybeans, or corn 12 months after treatment. Other crops should not be planted for 18 months after treatment. Oklahoma, New Mexico, west Texas fields may be planted to cotton or corn 12 months after treatment of 2.5 lb. product or less. If higher rate is used, only corn may be planted 12 months after treatment. Other crops may not be planted until 18 months after treatment. Sorghum may be replanted in previously treated soils. Do not make a second application.

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No. 5: Propazine, 1.2 to 2.5 lb./A applied after planting but before crop emergence.

Remarks for Treatments 4 and 5: Do not plant crops other than corn or sorghum for 18 months after treatment if more than 1.5 lb./A is applied; cotton can be planted the next season if 1.5 lb./A or less is used.

No. 6: Terbutryn, 1.0 to 2.4 lb/A applied after planting but before crop emergence. Remarks: Maximum rates for soils are 1 lb/A for sand, 1.5 lb/A for loamy sand, 2.4 lb/A for fine sandy loam, and 2.4 lb/A for clay loam. Short residual life allows use in any crop rotation, but 4 months should elapse from treatment to planting winter wheat.

No. 7: Paraquat, 0.5 to 1.0 lb/A applied before planting. Remarks: Kills established weed seedlings before planting crop. Use surfactant at 0.5% v/v.

No. 8: Atrazine, 1.2 to 3.0 lb/A applied postemergence when sorghum is more than 6 in. tall. Remarks: A non-phytotoxic oil may be added to increase activity. Use 1 to 2 gal/A emulsifiable oil in 20 to 30 gal/A of water. Also a surfactant at 0.5% v/v may be used to increase activity. Apply a broadcast or directed sprays to grass weeds up to 0.5 in. tall or broadleaf weeds up to 3 in. tall. Do not use following preemergence herbicide. Do not plant treated fields to any crop other than sorghum or corn within 18 months following application. Do not graze treated areas or feed treated forage to livestock for 21 days after treatment.

PROBLEM: Broadleaf leaf annual weeds

TREATMENT:

No. 1: Propachlor, 4.0 to 5.0 lb/A applied after seeding but before crop emergence. Remarks: Do not graze or feed forage or silage from treated fields to dairy animals.

No. 2: Propachlor, 0.5 to 1.0 lb/A + linuron 0.5 to 1 lb/A applied after seeding but before crop emergence. Remarks: Use of lower rates in mixture results in less soil persistence. Do not graze, feed forage, or silage from treated fields to dairy animals. Use is restricted to Great Plains area. Do not replant to crops other than field corn or sorghum within 4 months after application.

No. 3: Dicamba, 0.25 lb/A applied after weeds emerge and from 10 to 25 days after crop emergence. Remarks: Application at other times may injure crop. Do not graze treated fields or feed treated forage or ensile before mature grain stage.

No. 4: 2,4-D, 0.25 to 0.5 lb/A applied after weeds emerge and when crop ranges from 4 to 12 in. tall. Remarks: Apply as overtop spray to sorghum 4 to 12 in. tall; if crop is taller than weeds apply as a basally directed spray. Some injury to sorghum may occur but yields are not usually reduced.

No. 5: Diuron, 0.2 to 0.4 lb/A applied as a directed spray to sorghum 15 in. tall or taller and to weeds less than 2 in. tall. Remarks: Apply in 20 to 40 gal/A water containing 0.5% surfactant. Do not replant treated fields to any crop other than cotton or corn within 4 months following band treatment and within 6 months following broadcast treatment. Use restricted to Southwestern States.

PROBLEM: Perennial weeds

TREATMENT:

No. 1: Dalapon, 6.0 lb/A applied before planting to emerged weeds. Remarks: Use for control of perennial grasses such as johnsongrass when it is 6 to 12 in. tall, disk 3 to 4 days after treatment, and plant sorghum 2.5 weeks after disking.

No. 2: Dicamba, 0.25 lb/A applied after weeds emerge and from 10 to 25 days after crop emerges. Remarks: Controls perennial broadleaf weeds. Application at other times may injure crop. Do not graze treated fields, feed forage, or ensile before the mature grain stage.

PROBLEM: Red rice

TREATMENT:

No. 1: Propazine 3.2 lb/A applied before planting. Remarks: Incorporate in top 2 in. of medium and fine textured soil during final seedbed preparation. Do not plant cotton, corn, or soybeans on treated land within 12 months after treatment. Control is benefited by precise timely cultivations. Disking land after harvest keeps uncontrolled red rice plants from producing seed.

Soybeans

A wide choice of useful tools is available for controlling weeds in soybeans. These include intensive cultivation procedures, many possible treatments with herbicides, together with an almost infinite number of treatment combinations, involving cultivation, herbicides, and mixtures of herbicides.

The effectiveness and flexibility of mechanical control of weeds in soybeans can be easily underestimated. The use of herbicides is desirable and even necessary in many situations; however, research results from several different sections of the United States indicate that timely and precise cultivation, without the use of herbicides, successfully controls weeds under many conditions. Even perennial weeds, such as johnsongrass can be controlled by repeated cultivations during a 6- to 8-week period before planting. When this practice is combined with several timely early rotary hoeings (or other effective means of cultivation), an effective mechanical system for weed control in soybeans results.

Of course, the success of lengthy and intensive cultivation practices depends upon the vagaries of weather and herein lies the forte of herbicide treatments. Herbicides provide insurance against weed emergence during periods when rain prevents entry into a field. Therefore, in many situations, combination programs using the best mechanical and chemical procedures (in the most timely manner) produce optimum results for controlling weeds in soybeans. A clean seedbed is essential and this can be insured with either cultivation, herbicides, or both. The soybean farmer should always remember that the most critical weeds to control are those in the first flush which emerge with the soybeans or shortly thereafter.

Soybeans compete very well with weeds. If soybeans grow normally all season, growth of most annual weeds will be prevented if the crop is maintained weed-free for about 5 to 7 weeks after emergence.

Soybeans are grown in most areas of the United States under diverse environments. These guidelines can be used to devise potential systems for controlling weeds in soybeans. But, before finalizing a detailed program, local weed control specialists should be consulted for additional information pertaining to local conditions.

PROBLEM: Some perennial weeds and most annual weeds before planting soybeans.

TREATMENT:

- No. 1: Six to 10 cultivations at depths of 3 to 4 in. during a 6- to 8-week period before planting. Remarks: Controls johnsongrass, and annual weeds. Alternating disk with field cultivator is effective and economical. Cultivate twice in one day if wet weather delays schedule. Most effective during dry weather.

No. 2: 2 to 3 shallow cultivations at depths no greater than 2 in. during the 2 to 4 weeks before planting. Remarks: Controls most annual weeds with some suppression of perennials. Use only where weeds have emerged or are emerging. Less likely to reduce soil moisture in planting zone to critical levels than intensive cultivation at greater depths as described under Treatment 1.

No. 3: Paraquat, 0.5 to 1.0 lb./A. Remarks: Use nonionic surfactant as specified on label. Wet all weed growth with broadcast spray. Small annual weeds most susceptible with some suppression of larger weeds and of certain perennials. Observe all label restrictions.

No. 4: Dalapon, 3.7 to 5.5 lb./A for control of established johnsongrass and emerged seedlings. Remarks: Add surfactant as specified on label. Apply at least 8 days before planting only to areas infested with actively growing johnsongrass. Thoroughly disk or plow 3 days after application; then, wait at least 5 days before planting soybeans. Dry weather after cultivation may necessitate a longer waiting period.

No. 5: Trifluralin at 1.0, 1.5 or 2.0 lb./A for established johnsongrass control only. Remarks: Apply between October 15 and December 31 or from 0 to 10 weeks before planting. Use for 2 consecutive years. Since this treatment may injure soybeans or certain soils and other limitations are involved, see label for details and check with local weed control specialists before using this procedure.

PROBLEM: Most annual grasses and some broadleaf weeds with herbicides applied as preplant incorporated treatments.

TREATMENT:

No. 1: Dinitramine, 0.33 to 0.66 lb./A. Remarks: Apply during final seedbed preparation and before planting. Incorporate no deeper than 2 inches within 24 hrs. after application. See label precautions.

No. 2: Nitralin, 0.5 to 1.0 lb./A.

No. 3: Trifluralin, 0.5 to 1.0 lb./A.

Remarks for Treatments 2 and 3: Incorporate no deeper than 2 in. or 0.5 in. below planted seed. May be incorporated from 6 weeks before to immediately before planting. May be incorporated from mid-October through December on heavy soils where grasses and winter weeds are severe problems or where spring land preparation is difficult. See labels for other details and restrictions.

No. 4: Vernolate, 2.0 to 3.0 lb./A. Remarks: Incorporate 2 to 3 in. deep. Controls nutsedge and many annual weeds. Injection of vernolate

improves both weed control and crop tolerance. Seedling weeds not killed by vernolate are usually more susceptible to postemergence herbicides.

PROBLEM: Annual weeds with herbicides applied after planting but before emergence of weeds or soybeans.

TREATMENT:

No. 1: Alachlor, 1.0 lb./A.

No. 2: Chloramben, 2.0 to 3.0 lb./A.

No. 3: Chlorpropham, 2.0 to 4.0 lb./A. Remarks: Plant seed at least 1 inch deep.

No. 4: Chlorbromuron, 2.0 to 4.0 lb./A. Remarks: Use restricted to Central, Eastern, and Southern United States.

No. 5: Fluorodifen, 3.75 to 4.5 lb./A.

No. 6: Linuron, 1.0 to 3.0 lb./A. Remarks: Plant seed at least 1.75 inches deep.

No. 7: Metribuzen, 0.25 to 0.75 lb./A. Remarks: Do not apply to sandy soils (sandy loam and loamy sand) containing less than 2 percent organic matter. Plant soybeans at least 1.5 in. deep. Not suggested for use on 'Semmes' or 'Tracy' varieties. Follow label directions carefully and do not overdose.

No. 8: Naptalam, 2.0 to 3.0 lb./A. Remarks: Some large-seeded broadleaf weeds are not controlled by any of these herbicides. See respective labels for details and limitations. Do not graze or feed treated crop before crop maturity.

PROBLEM: Annual weeds which emerge with or after soybeans.

TREATMENT:

No. 1: Timely rotary hoeings followed by sweep cultivations or by treatments with herbicides.

No. 2: Chloroxuron, 0.5 to 1.0 plus either surfactant or nonphytotoxic oil as specified on the label. Remarks: Consult label for details on how and when to apply. Controls most small broadleaf weeds and suppresses many very small grass seedlings.

No. 3: Dinoseb, 1.9 lb./A. Remarks: Apply when weeds are first visible but while soybeans are still in cotyledon stage (before first true leaves expand). See label for precautions including temperature at time of application.

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No. 4: Herbicidal naphtha at 20 gal./A. Remarks: Controls most annual weeds and suppresses some perennial species. Must be precisely directed to lowest inch of stems of healthy plants to avoid severe crop injury.

No. 5: Linuron, 0.5 to 1.0 lb./A plus surfactant as specified on label. Remarks: Apply as basally directed spray in single application with the solution striking the soybean plants no higher than 2 to 3 in. above the ground. Controls a broad spectrum of annual weeds especially if they are less than 4 in. tall.

No. 6: 2,4-DB at 0.18 lb./A. Remarks: (a) Directed spray when soybeans are at least 8 in. tall on weeds 3 in. tall or shorter. Observe all precautions on label; (b) use as over-the-top salvage operation only when beans are overtopped with cocklebur. Spray 7 to 10 days before soybeans bloom to mid-bloom stage. Injury to soybeans will occur from over-the-top applications of 2,4-DB.

General remarks for all treatments: Many herbicides for soybeans are registered for use as tank mixtures. A few (for example, naptalam + dinoseb) are sold as packaged mixtures. See the respective labels for details and consult local weed control specialists for further information.

Sugarbeets

Cultivation of the crop after emergence controls small weed seedlings in and between the rows of sugarbeets. Mechanical thinners provide some weed control in rows. Various devices such as harrows with flexible tines successfully control small weed seedlings when the crop is large enough to tolerate minor mechanical injury.

Although cultural, cultivation, and good crop management practices help reduce problems with weeds in sugarbeets, these methods will not control all weeds satisfactorily. Use of herbicides controls weeds that are not killed by cultivation and permits production of high yields and good quality sugarbeets. However, herbicides must be used at precise rates and times on specific weeds to obtain effective weed control without severe injury to the crop.

PROBLEM: Annual weed grasses and broadleaf weeds.

TREATMENT:

No. 1: EPTC, 4.0 to 4.5 lb/A incorporated in late fall before ground freezes.
Remarks: Soil incorporate immediately after application. Use only in Minnesota and North Dakota.

No. 2: EPTC, 1.0 to 2.5 lb/A as spring preplanting treatment.

No. 3: Pebulate, 4.0 to 5.0 lb/A as spring preplanting treatment.

No. 4: Cycloate, 3.0 to 4.0 lb/A as spring preplanting treatment.

Remarks for Treatments 2 through 4: Incorporate herbicide in soil immediately after application. Use no higher rate than local experience has shown to be safe on the crop. Margin of crop safety to EPTC is narrow and use restricted to Iowa, Eastern Nebraska, North Dakota, South Dakota, and Minnesota.

No. 5: Endothall, 5.5 lb/A applied after planting but before emergence of crop. Remarks: Soil incorporate at least 2 inches.

No. 6: Phenmedipham, 1.0 to 1.5 lb/A applied postemergence when crop has two true leaves and weeds have fewer than four true leaves. Remarks: Apply in a band over-the-row to weed and crop foliage. May injure crop excessively when temperature is above 85 F. Do not apply to sugarbeets that have been injured by herbicide treatments, such as cycloate, applied before planting. Fails to control redroot pigweed. Do not apply later than 90 days before harvest.

No. 7: EPTC, 3.0 lb/A applied after thinning crop. Remarks: Apply after clean cultivation; incorporate or inject in soil immediately after application to a depth of 2 to 3 in. Use is restricted to Iowa, eastern Nebraska, North Dakota, South Dakota, and Minnesota.

No. 8: Trifluralin, 0.5 to 0.75 lb/A applied as a broadcast, overtop spray when plants are 2 to 6 in. tall. Remarks: Cover exposed crop roots

with soil before treatment to reduce root girdling. Incorporate herbicide in top 1 to 2 in. of soil immediately after application. Fails to control nightshade species.

No. 9: Pyrazon, 3.75 lb/A + dalapon, 2.0 lb/A applied postemergence when first two true leaves of crop are pea size. Remarks: Apply only in a band over-the-row to weed and crop foliage. Adequate soil mixture improves weed control. Do not use if pyrazon was applied before planting. Do not replant in treated soil.

PROBLEM: Most annual weed grasses

TREATMENT:

No. 1: Dalapon, 2.0 to 3.0 lb/A applied as directed spray after crop has emerged until it has four true leaves, and when weed grasses are less than 3 in. tall.

No. 2: Protham, 3.0 to 5.0 lb/A incorporated in soil immediately after application and immediately before planting crop. Remarks: Controls volunteer small grains, but does not control foxtail grasses.

No. 3: TCA, 5.0 to 7.0 lb/A applied after planting but before emergence of crop. Remarks: Fails to control wild oats and volunteer small grains.

PROBLEM: Most annual broadleaf weeds

TREATMENT:

No. 1: Pyrazon, 3.75 lb/A applied immediately before planting. Remarks: Incorporate in soil immediately after application. Crop may be injured on coarse-textured soils in the Pacific Northwest. Use limited to Plains, Mountain and Western States. Do not replant in treated soil. If crop is lost, do not plant other crops in same season.

No. 2: Pyrazon, 3.75 lb/A applied immediately or within 3 days after planting. Use limited to Plains, Mountain and Western States. If crop is lost, do not plant other crops in same season.

No. 3: Pyrazon, 3.75 lb/A applied after crop has emerged but before weeds have more than two true leaves.

PROBLEM: Wild oats

TREATMENT:

No. 1: Diallate, 1.5 to 2.0 lb/A incorporated in soil immediately before planting crop.

No. 2: Protham, 3.0 to 5.0 lb./A incorporated in soil immediately after application and 1 to 2 days before planting crop.

No. 3: Barban, 0.6 to 0.75 lb/A applied postemergence when wild oats have two leaves. Remarks: Apply broadcast to foliage of weeds and crop. Do not graze treated fields until after harvest of crop.

PROBLEM: Smartweed, wild buckwheat, and some other broadleaf weeds

TREATMENT:

No. 1: Endothall, 0.75 to 1.46 lb/A applied after crop has emerged until it has six true leaves, and when weeds are less than 2.5 in. tall.
Remarks: Use lower rate when crop has less than two true leaves.
Herbicides may injure the crop excessively, especially very small plants, when temperature exceeds 80 F. Do not apply later than 40 days after emergence.

Sugarcane

Weeds are most competitive when sugarcane is becoming established after planting or ratooning. Therefore, an effective weed control program involves timely control of weeds with a combination of herbicide treatments and cultivations, and the use of cultural practices that promote good growth of sugarcane.

In Louisiana, a crop of sugarcane that has grown for 3 years may be severely infested with johnsongrass. Fallowing the land by frequent plowing for one spring and summer effectively kills the majority of johnsongrass rhizomes and reduces the population of weed seed in the soil. Fields are effectively fallowed by plowing under johnsongrass each time it reaches a height of about 14 inches.

The following herbicide treatments control most weeds in sugarcane. Specific practices for certain producing areas are described.

PROBLEM: Annual grasses and many small-seeded broadleaf weeds such as barnyardgrass, junglerice, crabgrass, goosegrass and pigweed.

TREATMENT:

No. 1: Atrazine, 3 to 4 lb./A.

No. 2: Simazine, 3 to 4 lb./A.

No. 3: Diuron, 2 to 4 lb./A.

No. 4: Fenac, 8 lb./A.

No. 5: CDAA, 8 to 10 lb./A + 2,4-D, 2 lb./A.

No. 6: CDAA, 6 lb./A + atrazine, 4 lb./A.

No. 7: Ametryne, 4 lb./A.

Remarks for treatments 1 through 7: Apply before weeds emerge and after planting or ratooning the crop. If sugarcane has emerged, apply treatments as basally directed sprays with the exception that atrazine and simazine can be applied over-the-top of cane plants. For treatments 4 through 7 use only on organic soils of Florida. For treatment no. 7 use only in Hawaii.

PROBLEM: Johnsongrass from seed, many annual grasses, and many winter and summer broadleaf weeds.

TREATMENT:

No. 1: Fenac, 3.6 to 6 lb./A.

No. 2: Terbacil, 1.6 to 3.2 lb./A.

No. 3: Trifluralin, 1 to 2 lb./A.

Remarks for Treatments 1 through 3: Apply before weeds emerge in summer or fall after planting and in early spring on plant or ratoon cane. Apply treatments in a 30 in. band over the row. Incorporate trifluralin immediately after application. Trifluralin also controls itchgrass, but it fails to control most broadleaf weeds. Use primarily in Louisiana.

PROBLEM: Emerged seedling grasses or broadleaf weeds in Florida and Hawaii and many perennial weeds in Hawaii.

TREATMENT:

No. 1: Atrazine, 3.2 lb./A.

No. 2: Atrazine, 0.8 lb./A + 2,4-D, 0.5 lb./A + surfactant.

No. 3: Diuron, 0.8 lb./A + 2,4-D, 0.5 lb./A + surfactant.

No. 4: Ametryne, 0.4 to 0.8 lb./A + 2,4-D, 0.5 lb./A + surfactant.

No. 5: Fenac 1.5 to 2.0 lb./A + 2,4-D, 1.5 to 2.0 lb./A + surfactant.

No. 6: Ametryne 3.2 lb./A.

No. 7: Diuron, 3.2 lb./A + surfactant.

No. 8: Diuron 3.2 lb./A + surfactant + 2,4-D, 1.0 to 2.0 lb./A.

No. 9: Ametryne, 3.2 lb./A + 2,4-D, 1.0 to 2.0 lb./A.

Remarks for Treatments 1 through 9: Apply as basally directed sprays; use surfactant at 0.5 percent V/V. For treatments 1 through 5: Use primarily in Florida; apply before weeds are 3 in. tall. Repeat applications may be required. For treatments 6 through 9: Use only in Hawaii; apply post-emergence to weeds of various sizes and any time before cane closes in, repeat applications may be required.

PROBLEM: Emerged established grasses including perennials, such as johnsongrass, bermudagrass, napiergrass, guineagrass, dallisgrass, and many seedling weed grasses.

TREATMENT:

No. 1: Dalapon, 3.5 to 4.5 lb./A.

No. 2: Dalapon, 3.5 to 4.5 lb./A + TCA, 8 to 17 lb./A.

Remarks for Treatments 1 and 2: Apply postemergence to weeds of variable sizes. Apply as basally directed sprays in Florida and Hawaii or in Louisiana as over-the-top sprays to rhizomatous johnsongrass and ratoon sugarcane in early spring.

Repeat treatments may be required, but crop may be severely injured if foliage is wet repeatedly.

PROBLEM: Emerged broadleaf weeds.

TREATMENT:

No. 1: Silvex, 1 to 2 lb./A.

No. 2: 2,4-D, 2 lb./A.

Remarks for Treatments 1 and 2: Apply postemergence to rapidly growing weeds. Silvex and 2,4-D control checkweed, henbit, morningglory, and pigweed; silvex also controls dogfennel, groundcherry, haole koa, nightshade, and wild lettuce.

Tobacco (Transplanted)

PROBLEM: Nutsedges and many annual weeds.

TREATMENT: Pebulate, 3 to 4 lb./A. Remarks: See label for incorporation or subsurface application instructions. Read the label carefully for limitations applicable to your geographical area.

PROBLEM: Most annual grasses and some small-seeded broadleaf weeds.

TREATMENT: Diphenamid, 4 to 6 lb./A. Remarks: Apply immediately after transplanting tobacco in weed-free soil. If no rain is expected for several days, an application of irrigation water will enhance effectiveness of the herbicides.

NOTE: For information on controlling weeds in tobacco plantbeds see your local agricultural specialists.

WEED CONTROL IN HORTICULTURAL CROPS

Weed control in horticultural crops is a highly complex problem because of the large number of different types of crops and their specific cultural, climatic, and soil requirements plus the many species of weeds associated with these environmental and cultural conditions. Horticultural crops include vegetables, deciduous tree fruits and nuts, citrus and subtropical fruits and nuts, small fruits, and ornamental plants.

Several methods of weed control are used separately and in various combinations in horticultural crops because of the complexity of the weed problem. Mechanical cultivation is usually effective in controlling weeds between the rows but does not efficiently control weeds within the row because of the proximity of weed and crop plants. In periods of continued or excessive rainfall, mechanical cultivation is impossible and the weeds normally controlled by this method overgrow the crop. Hand hoeing and hand pulling of weeds have been used to supplement mechanical cultivation in many crops in the past. The scarcity and cost of labor since 1950, however have made hand weeding impractical in many instances and impossible in others.

Cultural practices involving suitable rotation of broadcast and row crops and crops of differing growth habits can be used to limit the vigor and spread of certain weeds. For example, sweet potatoes are very strong competitors and can be used effectively in rotations to suppress weeds. Broadcast-planted soybeans and sorghum are also effective smother crops for use in rotation.

The inefficiency of mechanical cultivation, the scarcity of hand labor, and the limitations of crop-rotation practices have stimulated intensive research in chemical weed control. The development of effective herbicides is providing the farmer with new technological tools of great potential for use in combination with cultural and mechanical methods of weed control in horticultural crops.

Examples of methods that control weeds in horticultural crops follow. This information is intended to show the broad general areas of herbicidal effectiveness on these crops. Rate ranges are given because specific rates vary with locality and depend on climate, soil composition and cultural practices. Weed control recommendations based on local research have been prepared by many weed specialists in State agricultural experiment stations. The recommendations are revised annually to keep abreast of current research. These specialists provide specific herbicide and rate recommendations for each locality. The reader should consult these specialists for specific guidance.

Herbicides are selected on the basis of their weed specificities. For example, one herbicide may be highly effective for control of germinating annual weed grasses and ineffective for germinating broadleaf weeds. Conversely, others may be effective on only broadleaf weeds. The grower must therefore identify the weed and know its time of emergence and growth as a basis for selecting the correct herbicide and time of application and the associated cultural and mechanical methods.

The herbicide formulation to be used, whether granule or spray, will depend on the weed problem. In general, granules should be used in postemergence or posttransplanting treatments to crops after clean cultivation. This takes advantage of the physical selectivity of granules to minimize injury to the crop. Granules may also be used as preplanting and preemergence treatments as a matter of convenience.

Some contact herbicides including DNBP, paraquat, and petroleum solvents are effective as directed sprays to kill young rapidly growing weeds in many fruit and nut crops and ornamentals. Specific directions for use under local conditions and a list of approved crop uses can be obtained from State experiment station specialists.

See list of metric equivalents for weight, volume, area, and linear dimensions in the appendix.

Vegetables

More than 50 vegetable crops are grown commercially in the United States. Chemical weed control methods fill a critical need in vegetable production. Examples of effective chemical methods follow:

Artichokes

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Diuron at 3.2 lb./A applied as a single directed spray immediately after clean cultivation in late fall or early winter. Remarks: Do not replant to any crop within 2 years of last treatment.

No. 2: Simazine at 4 lb./A applied as a single directed spray immediately after last cultivation in fall.

Asparagus

PROBLEM: Perennial weed grasses.

TREATMENT: Dalapon at 7 lb./A applied as a directed spot spray on weedy areas before harvest begins or after harvest is completed. Remarks: Disk after harvest, allow perennial weed grasses to make 4 to 6 in. of regrowth before spraying. Disk the treated area 2 weeks after treatment. Repeat spraying procedure on regrowth. Keep off asparagus ferns.

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Chloramben at 3 lb./A applied to soil immediately after seeding.

No. 2: Diuron at 3.2 lb./A applied 4 weeks before spears emerge or during early cutting season and repeat immediately after harvest is completed in non-irrigated plantings. Remarks: Do not replant treated area to any crop within 2 years after last application.

No. 3: Diuron at 3.2 lb./A applied in late November or December to irrigated crop in Washington state only. Remarks: Do not replant treated areas to any crops within 2 years after last application.

No. 4: Simazine at 2 lb./A applied 4 weeks before spears emerge and repeat following clean cultivation after harvest is completed.

No. 5: 2,4-D (sodium salt) at 2 lb./A applied 4 weeks before spears emerge or after disking following last harvest. Remarks: Avoid all herbicide use during or immediately before the harvest season because of possible residue accumulation and growth distortion of spears that destroys their quality.

No. 6: 2,4-D (sodium salt) at 1.0 lb./A applied during early growth of direct seeded asparagus plantings.

Beans, Lima

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDAA at 4 lb./A applied before bean plants emerge. Remarks: Use only east of Rocky Mountains.

No. 2: CDEC at 6 lb./A applied as a single broadcast treatment before bean plants emerge.

No. 3: Chloramben at 4 lb./A applied as a single directed spray before weeds and bean plants emerge.

No. 4: Chlorpropham at 2 to 6 lb./A applied before weeds and bean plants emerge. Remarks: Plant seed at least 1 in. deep.

No. 5: Dinoseb (Ethanol and isopropylamine salts) at 4.5 to 9 lb./A applied before emergence of bean plants. Remarks: Do not use on light sandy soil.

No. 6: Dinoseb (triethanolamino salt) at 4 to 6 lb./A applied before emergence of bean plants. Remarks: Do not use on light sandy soils.

PROBLEM: Perennial weed grasses.

TREATMENT: Dalapon at 6 lb./A applied as a single spring preplanting treatment and followed by plowing in 4 days. Wait 4 to 5 weeks before planting. Remarks: Dalapon is effective on actively growing grasses.

Beans, Snap

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDAA at 4 lb./A applied before weeds and bean plants emerge. Remarks: Use only east of Rocky Mountains.

No. 2: CDEC at 6 lb./A applied as a single treatment before bean plants emerge.

No. 3: Chlorpropham at 2 to 6 lb./A applied before weeds and bean plants emerge. Remarks: Plant seed at least 1 in. deep.

No. 4: DCPA at 6 to 10.5 lb./A applied immediately after planting. Remarks: Do not graze treated areas or feed plants to livestock.

No. 5: Dinoseb (alkanolamine salt) at 9 lb./A applied before bean plants emerge. Remarks: Do not use on light sandy soil. At ground-cracking, 1.5 lb./A following preplant soil incorporation of dinitroaniline herbicide.

No. 6: EPTC at 3 to 4 lb./A applied to soil and incorporated before planting or after clean cultivation of established bean crop.

No. 7: Nitralin at 0.5 to 1.5 lb./A applied to soil and incorporated before planting or applied and soil incorporated before crop emerges.

No. 8: Trifluralin 0.5 to 0.75 lb./A applied as soil incorporated treatment before planting.

PROBLEM: Emerged annual and perennial weed grasses.

TREATMENT: Dalapon at 6 lb./A applied as a spray on emerged perennial and annual grasses. Plow 4 days later. Plant beans 4 or 5 weeks later. Remarks: Dalapon is only effective in controlling grasses.

Beans, Pole

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT: EPTC at 3 lb./A applied to the soil and incorporated before planting.

PROBLEM: Annual weed grasses.

TREATMENT:

No. 1: Dalapon at 6 lb./A applied on growing grasses in spring. Wait 4 days and plow. Plant beans in 4 to 5 weeks.

No. 2: Dinoseb (ethanol and isopropanolamine salts) at 3-6 lb./A at ground cracking.

Beets

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Pyrazon at 4 lb./A applied before weeds and beets emerge or immediately after crop emerges but before weeds emerge.

Use Pesticides Safely-Follow the Label

No. 2: Sodium chloride at 200 to 300 lb./A applied after crop emerges but before weeds emerge.

Broccoli

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 6 lb./A applied to soil and incorporated before planting once per year; or applied to soil surface immediately after planting once per year followed by sprinkler or furrow irrigation. Remarks: Do not plant other than label specified crops for 18 months after treatment.

No. 2: Nitralin at 1.5 lb./A applied to the soil and incorporated 0-6 weeks before or applied and incorporated immediately after transplanting.

No. 3: Nitrofen at 6 lb./A applied before weeds and crop emerge in direct seeded plantings; or nitrofen at 6 lb., per acre applied 2 weeks after direct seeded crop emerges; or nitrofen at 6 lb. per acre applied 2 weeks after transplanting.

No. 4: Trifluralin at 0.75 lb./A applied and soil incorporated before direct seeding planting; or 1.0 lb./A applied to the soil and incorporated before transplanting.

Brussels Sprouts

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDEC at 6 lb./A applied before crop and weeds emerge in direct-seeded crop or immediately after transplanting. In California only use 8 lb./A of granular formulation immediately after direct seeding or transplanting.

No. 2: DCPA at 10.5 lb./A applied immediately after direct seeding or immediately after transplanting.

No. 3: Bensulide at 4 to 6 lb./A applied to soil and incorporated once per year before planting; or applied to soil surface immediately after planting once per year followed by sprinkler or furrow irrigation. Remarks: Do not plant other than label specified crops for 18 months after treatment.

No. 4: Nitralin at 1.5 lb./A applied to the soil and incorporated 0-6 weeks before transplanting; or after transplanting.

No. 5: Trifluralin at 0.75 to 1.0 lb./A applied to the soil and incorporated before direct seeding; or before transplanting.

Cabbage

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 4 to 6 lb./A applied once per year as a soil incorporated treatment before planting in Southern States and California only.

No. 2: CDAA at 4 lb./A applied immediately after planting. Remarks: Use only in Wisconsin, Illinois, Indiana and Florida.

No. 3: CDAA at 6 lb./A applied as a single directed spray or overall granule application after transplanting but before weeds emerge.

No. 4: CDEC at 6 lb./A applied after direct seeding or immediately after transplanting. In California only, use at 8 lb./A immediately after direct seeding or immediately after transplanting.

No. 5: DCPA at 10.5 lb./A applied to the soil immediately after seeding; or immediately after transplanting.

No. 6: Nitralin at 0.5 to 1.5 lb./A applied to the soil and incorporated 0-6 weeks before transplanting; or after transplanting.

No. 7: Nitrofen at 6 lb./A applied before crop emerged; or 2 weeks after emergence but before weeds emerge; or to emergent purslane; or 2 weeks after transplanting.

No. 8: Trifluralin at 0.5 to 1 lb./A applied to the soil and incorporated before direct seeding; or before transplanting.

Cantaloupes

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 4 to 6 lb./A applied once per year as a soil incorporated treatment before planting.

No. 2: CDEC at 4 lb./A applied before crop and weeds emerge.

No. 3: DCPA at 10.5 lb./A applied 4 to 6 weeks after seeding following clean cultivation to remove all growing weeds.

No. 4: Naptalam at 3 lb./A applied before emergence of crop and weeds.

No. 5: Stoddard solvent at 100 gal./A applied on emerged weeds before crop emerges.

No. 6: Trifluralin at 0.5 to 1.0 lb./A applied as a directed spray soil incorporated treatment when crop is in 3 to 4-leaf stage.

Caraway

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT: Stoddard solvent at 80 to 100 gal./A applied as spray on emerged weeds before or after crop emerges. Remarks: Use full strength. Thoroughly wet weed foliage with oil. Does not kill ragweed or galensoga.

Carrots

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 4 to 6 lb./A applied once per year as a soil incorporated treatment before planting.

No. 2: Chloroxuron at 4 lb./A applied before weeds and crop emerge.

No. 3: Chloroxuron at 4 lb./A applied as a single broadcast spray after carrots have true leaves but before weeds emerge. Remarks: Do not apply within 60 days before harvest.

No. 4: Chlorpropham at 6.5 lb./A applied before crop and weeds emerge; or 4 lb./A applied after clean cultivation of emerged crop with 5 true leaves.

No. 5: Linuron at 1.5 lb./A applied to the soil and weeds before crop emerges. Remarks: Linuron kills germinating and emerged small weeds. Do not plant treated areas to crops not on label within 4 months after application.

No. 6: Nitrofen at 6 lb./A applied before crop emerges; or after 2 weeks after crop emerges.

No. 7: Stoddard solvent at 100 gal./A applied as a wetting spray on emerged weeds before crop emerges; or after weeds and crop emerge. Remarks: Solvent does not kill ragweed or galensoga.

Cauliflower

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Bensulide at 4 to 6 lb./A applied once per year as a soil incorporated treatment before planting.
- No. 2: CDEC at 6 lb./A applied immediately after direct seeding or immediately after transplanting. In California only, use granular formulation at 8 lb./A immediately after seeding or transplanting.
- No. 3: DCPA at 10.5 lb./A applied at seeding time or immediately after transplanting.
- No. 4: Nitrofen at 6 lb./A applied before direct seeded crop emerges; or 2 weeks after crop emerges; or 2 weeks after transplanting but before weeds emerge.
- No. 5: Propham at 5 lb./A applied before or after crop emerges but before weeds emerge, or 11 lb./A applied before planting in late winter or early spring.
- No. 6: Trifluralin at 0.75 lb./A applied as soil incorporated treatment before direct seeding; or 1.0 lb./A applied as soil incorporated treatment before transplanting.

Celery

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: CDAA at 4 lb./A applied 2 to 3 days after transplanting. Repeat 3 weeks after transplanting. Remarks: Use only in Florida.
- No. 2: CDEC at 6 lb./A applied immediately after transplanting and repeated in 3 weeks.
- No. 3: Nitrofen at 6 lb./A applied before direct seeded crop emerges; or 2 weeks after crop emerges; or 2 weeks after transplanting.
- No. 4: Prometryne at 0.8 lb./A applied as a broadcast spray after crop reaches 2-5 leaf stage in Florida only.
- No. 5: Prometryne at 3.2 lb./A applied after transplanting in California, Florida and Hawaii only. Remarks: Limit to 2 treatments per crop.
- No. 6: Stoddard solvent 80-100 gal./A after weeds emerge and before or after crop emerges. Remarks: Do not use stoddard solvent later than 6 weeks before harvest. Solvent does not control ragweed or galensoga.
- No. 7: Trifluralin at 0.5 to 1.0 lb./A applied as soil incorporated treatment before seeding; or applied before transplanting.

Collards

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDEC at 4 lb./A applied immediately after seeding.

No. 2: DCPA at 10.5 lb./A applied immediately after seeding.

No. 3: Trifluralin at 0.5 to 0.75 lb./A applied and soil incorporated before planting.

Cucumbers

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 1.5 to 6 lb./A applied and soil incorporated 0 to 3 days before planting. Remarks: Do not replant to crops not on label for 1 year after treatment.

No. 2: CDEC at 4 lb./A applied immediately after planting.

No. 3: DCPA at 10.5 lb./A applied to soil 4 to 6 weeks after seeding.

No. 4: Dinoseb at 1.0 lb./A applied before crop emerges.

No. 5: Naptalam (sodium salt) at 3 to 6 lb./A within 2 days after seeding; or immediately after transplanting.

No. 6: Nitralin at 0.75 to 1.5 lb./A applied to soil and incorporated no later than 3 days after seeding. Remarks: Do not replant to crops not on label for 1 year after treatment.

No. 7: Stoddard solvent at 100 gal./A applied on emerged weeds before crop emerges. Remarks: Solvent does not kill ragweed or galensoga.

No. 8: Trifluralin at 0.5 to 1.0 lb./A applied as directed spray and soil incorporated after crop emerges and is in 3 to 4 leaf stage.

Eggplant

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT: DCPA at 10.5 lb./A applied to soil immediately after transplanting and after last clean cultivation. Remarks: All emerged weeds should be destroyed by cultivation or hand weeding before application of herbicide.

Endive

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT: CDEC at 4 lb./A applied immediately after planting seed.

Escarole

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT: CDEC at 4 lb./A applied immediately after planting seed.

Garlic

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Chlorpropham at 6 lb./A applied to fall planted sets; or as directed spray after crop emerges.

No. 2: DCPA at 6 to 10.5 lb./A applied at time of seeding; or immediately after transplanting.

No. 3: Trifluralin at 1.0 lb./A applied to soil and incorporated before planting in Western States only.

Kale

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDEC at 4 lb./A applied immediately after planting seed.

No. 2: DCPA at 10.5 lb./A applied immediately after planting.

No. 3: Trifluralin at 0.75 lb./A applied and soil incorporated before planting.

Lentils

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Barban at 0.38 lb./A applied before 4 leaf stage of crop for control of wild oats. Apply when wild oat plants are in 2-leaf stage.

No. 2: Diallate at 1.5 lb./A applied to the soil and incorporated. Plant within 3 weeks.

No. 3: Diallate at 1.5 lb./A applied to the soil and incorporated immediately after planting.

No. 4: Propham at 4 lb./A applied before planting.

No. 5: Trifluralin at 0.75 lb./A applied and soil incorporated before planting.

Lettuce

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Benefin at 0.75 to 1.5 lb./A applied as soil incorporated treatment within 10 weeks before planting.

No. 2: Bensulide at 4 to 6 lb./A applied once each year as a soil incorporated treatment before planting. Remarks: Do not replant treated areas to crop not on label for 18 months after last treatment.

No. 3: CDEC at 4 lb./A applied immediately after planting seed.

No. 4: Chlorpropham at 3 lb./A applied before weed and crop emerges.

No. 5: DCPA at 10.5 lb./A applied 1 to 6 weeks after seeding of head lettuce; or 10.5 lb./A applied 1 to 3 weeks after leaf lettuce crop emerges.

No. 6: Paraquat at 1.0 lb./A applied spray to emerged weeds before planting or applied as spray to emerged weeds before crop emerges.

No. 7: Propham at 6 lb./A applied as soil incorporated treatment immediately before planting; before emergence of crop; or after emergence of crop when lettuce has four or more leaves but before weeds emerge after clean cultivation.

No. 8: Stoddard solvent at 75 gal./A sprayed on emerged weeds before crop emerges.

Mint

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Dinoseb (ethanol and isopropanolamine salts) at 4.5 lb./A applied before crop emerges; or at emergence before crop is 1 in. tall.
Remarks: Dinoseb kills germinating and seedling weeds.

No. 2: Stoddard solvent at 100 gal./A applied on growing weeds before crop emerges. Remarks: Solvent does not kill ragweed or galensoga.

No. 3: Terbacil at 1.6 lb./A applied in spring or fall after last cultivation before peppermint and spearmint emerge. Remarks: Do not replant treated areas to any other crop within 2 years.

No. 4: Trifluralin at 0.75 lb./A applied as soil incorporated treatment in dormant peppermint and spearmint plantings in Oregon, Washington, and Idaho only.

Mustard Greens

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDEC at 4 lb./A applied immediately after planting seed.

No. 2: DCPA at 10.5 lb./A applied immediately after seeding.

No. 3: Trifluralin at 0.5 to 0.75 lb./A applied and soil incorporated before planting.

Okra

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDEC at 4 lb./A applied immediately after planting seed. Remarks: Do not use on Florida sands.

No. 2: Diphenamid at 5 lb./A applied immediately after planting. Remarks: Do not graze treated areas. Do not replant treated areas to crops not on label for 6 months after treatment.

No. 3: Trifluralin 0.5 to 1.0 lb./A applied and soil incorporated before planting.

Onions

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 4 to 6 lb./A applied once per year as a soil incorporated treatment before planting.

No. 2: CDAA at 6 lb./A applied before direct seeded crop and weeds emerge.

No. 3: CDAA at 6 lb./A applied immediately after transplanting.

- No. 4: CDAA at 6 lb./A applied as a directed spray or granule application after crop emerges and 3 leaves have formed but only after clean cultivation of soil. Remarks: Do not use on green onions. Granule application may be repeated at 4 week intervals. Do not apply sprays later than 45 days before harvest. Do not apply granules later than 30 days before harvest.
- No. 5: Chloroxuron at 4 lb./A applied after (dry bulb crop) or onion seedlings emerge and reaches 2 to 3 leaf stage and before weeds are 2 in. tall. Remarks: Do not apply within 30 days before harvest
- No. 6: Chlorpropham at 8 lb./A on set plantings 8 lb./A applied immediately after planting.
- No. 7: DCPA at 10.5 lb./A applied to soil at seeding; transplanting; or at last cultivation up to 14 weeks after seeding or transplanting but before weeds emerge.
- No. 8: Dinoseb (ammonium salt) at 1.5 lb./A applied after direct seeded crop emerges and is in 2-leaf stage and is 4-6 in. tall and before weeds emerge; or 1.0 lb./A applied immediately after transplanted sets are established and growth has begun.
- No. 9: Monuron at 1.6 lb./A applied 2 days before dry bulb crop emerges; or when crop has 1-2 leaves. Repeat as directed spray application after last cultivation.
- No. 10: Nitrofen at 4 lb./A applied before crop emerges; or after crop emerges and is in the 2 to 3 leaf stage and weeds are 1 to 2 in. tall.
- No. 11: Stoddard solvent at 75 gal./A on emerged weeds before crop emerges; or 40 gal./A applied after crop emerges as directed spray on growing weeds.

Parsley

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Nitrofen at 6 lb./A before crop emerges; or 2 weeks after crop emerges but before weeds emerge.
- No. 2: Stoddard solvent at 100 gal./A applied as spray before or after crop emerges on growing weeds. Remarks: Solvent does not kill ragweed or galensoga. Do not apply within six weeks of harvest.

Parsnip

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Linuron at 1.5 lb./A applied before weeds and crop emerge. Remarks: Plant crop 0.5 in. deep. Do not plant treated areas to any crop not on label within 4 months after treatment.

No. 2: Stoddard solvent at 100 gal./A applied as spray on growing weeds before; or after crop emerges.

Peas, English Canning and Freezing

PROBLEM: Wild oats.

TREATMENT:

No. 1: Barban at 0.38 lb./A applied when wild oats are in 2-leaf stage and crop has reached 6-leaf stage. Remarks: Do not feed lower 3 in. of vines (stubble) to livestock.

No. 2: Dalapon at 0.74 lb./A applied as spray on wild oat plants when peas are 2 to 6 in. tall and have 4 to 6 nodes. Remarks: Do not apply within 25 days before harvest.

No. 3: Diallate at 1.25 lb./A applied to the soil and incorporated. Plant within 3 weeks after treating and before wild oats emerge.

No. 4: Diallate at 1.25 lb./A applied to the soil immediately after planting and incorporated.

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDAA at 4 lb./A applied before weeds and crop emerge.

No. 2: EPTC at 2.0 lb./A applied to plantings of green processing peas as soil incorporated treatment before planting in Washington State only.

No. 3: MCPB at 1.5 lb./A applied as overall spray when peas have 6 to 12 nodes and before flower buds form. Remarks: Prevents flower bud formation of Canada thistle and controls broadleaf weeds such as smartweed and ragweed.

No. 4: Propachlor at 4.9 lb./A applied in green processing peas before weeds and crops emerge.

No. 5: Trifluralin at 0.75 lb./A applied as soil incorporated treatment before planting.

Peas, Dried Field

PROBLEM: Wild oats and wild barley.

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TREATMENT: Triallate at 1.25 lb./A applied as a soil incorporated treatment 3 weeks before planting; or before weeds and crop emerge after planting. Remarks: Do not graze treated areas.

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Chlorpropham at 4 lb./A applied and disked 4 in. deep 2 days before planting; or 6.6 lb./A applied as a preemergence treatment.

No. 2: Triallate at 1.25 lb./A applied as a soil incorporated treatment 3 weeks before planting; or after planting but before weeds emerge.

Remarks: Do not graze treated areas.

Peas, Seed Crop

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT: Dinoseb (ethanol and isopropanolamine salts) 4.5 to 9 lb./A applied as a preemergence spray; or 2.25 lb./A on growing weeds when peas 2 to 8 in. tall and before flower buds appear. Remarks: Do not graze treated areas or feed treated forage within 40 days after treatment.

Peas, Southern

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Chlorpropham at 6 lb./A applied before weeds and crop emerge. Remarks: Plant seed at least 1 inch deep.

No. 2: DCPA at 10.5 lb./A applied immediately after planting.

No. 3: Nitralin at 0.5 lb./A applied and incorporated into the soil before planting.

No. 4: Trifluralin at 0.5 to 1 lb./A applied to soil and incorporated before planting.

Peppers

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 4 to 6 lb./A applied as a single annual soil incorporated treatment before planting; or as a soil surface treatment immediately after seeding bell peppers in Southeastern and Southwestern states.

Remarks: Do not plant treated areas to crops not approved on the label

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for 18 months after last treatment.

No. 2: Chloramben at 4 lb./A of granular formulation applied before weeds emerge and 3 to 30 days after transplanting or before weeds emerge after last clean cultivation.

No. 3: Chlorpropham at 6 lb./A applied before weeds and crop emerge.

No. 4: DCPA at 10.5 lb./A applied immediately after transplanting and immediately after last cultivation but no later than 6 weeks after transplanting.

No. 5: Diphenamid at 5 lb./A applied immediately after seeding; within 4 weeks after crop emerges but before weeds emerge; or within 4 weeks after transplanting.

No. 6: Methyl bromide at 2 lb./A 100 sq. ft. before seeding for fumigation of plant bed soils. Remarks: For production of transplants only.

No. 7: Nitralin at 0.5 to 1.5 lb./A applied as a soil incorporated treatment 0-6 weeks before transplanting or immediately after transplanting. Remarks: Do not replant treated areas to crops not on the label for 1 year.

No. 8: Paraquat at 1 lb./A on emerged weeds before crop emerges.

No. 9: Trifluralin at 0.5 to 1 lb./A applied as a soil incorporated treatment before transplanting.

Potatoes

PROBLEM: Annual and perennial weed grasses.

TREATMENT:

No. 1: Dalapon at 11.1 lb./A applied on emerged weed grasses in the fall before planting.

No. 2: Dalapon at 7.4 lb./A applied as a single spray on emerged weed grasses before crop emerges.

No. 3: Dalapon at 6 lb./A applied as a single spray on emerged weed grasses before planting in spring.

No. 4: Dalapon at 3.7 lb./A applied as a single directed spray on emerged weed grasses after crop emerges.

No. 5: Diallate at 2 lb./A applied and incorporated into the soil followed by planting within 3 weeks. Remarks: Use only in North Dakota, Minnesota and Montana.

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Ametryne at 2 lb./A applied after last clean cultivation.

No. 2: CDAA at 4 lb./A applied as a granule formulation immediately after last cultivation or tilling.

No. 3: CDAA at 3 lb./A applied immediately after planting in combination with 3 lb./A of CDEC.

No. 4: DCPA at 10.5 lb./A applied at planting time; at drag-off, or immediately after last cultivation.

No. 5: Dinoseb (triethanolamine salt) at 6 lb./A applied before crop emerges.

No. 6: Diphenamid at 6 lb./A applied before weeds and crop emerge; or as a directed spray after last cultivation but before weeds emerge.
Remarks: Do not apply within 50 days before harvest.

No. 7: Diuron at 0.8 lb./A applied before weeds or crop emerge.

No. 8: EPTC at 6 lb./A applied as soil incorporated treatment before planting; or just before emergence after drag-off and/or 4 lb./A applied as a soil incorporated treatment applied as a directed spray after last cultivation but before weeds emerge. Remarks: Do not apply within 45 days before harvest.

No. 9: Linuron at 2 lb./A applied after drag-off while weeds are small and before crop emerges in Pacific Northwest and east of Rocky Mountains only.

No. 10: Metobromuron at 3 lb./A applied as a single spray immediately after planting or immediately after drag-off. Remarks: Do not treat within 90 days before harvest.

No. 11: Paraquat at 1.0 lb./A applied to emerged weeds after planting but before crop emerges.

No. 12: Stoddard solvent at 100 gal./A applied on emerged weeds before crop emerges.

No. 13: Trifluralin at 1.0 lb./A as a soil incorporated treatment applied before weeds and crop emerge; or after drag-off.

Pumpkins

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Chloramben at 4 lb./A applied as a single spray immediately after planting.

No. 2: Dinoseb (triethanolamine salt) at 6 lb./A applied before crop emerges. Remarks: Do not use on light sandy soils.

Spinach

PROBLEM: Henbit and weed grasses.

TREATMENT: CDEC at 4 lb./A applied immediately after planting or within 30 days after crop emerges and repeat in 30 days. Remarks: Do not use on muck soils.

PROBLEM: Chickweed and weed grasses.

TREATMENT: Chlorpropham at 2 lb./A applied immediately after planting.

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Cycloate at 4 lb./A as a soil incorporated treatment applied before planting.

No. 2: Monuron at 1.2 lb./A applied immediately after planting.

No. 3: Norea at 1.6 lb./A applied immediately after planting. Remarks: Do not plant treated soils to crops not on label within 5 months after treatment.

No. 4: Propham at 4 lb./A applied without disking in just before planting; or at 6 lb./A applied before weeds and crop emerge; or at 11 lb./A applied in late winter or early spring before planting.

Squash

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 4 to 6 lb./A as a soil incorporated treatment applied immediately before planting. Remarks: Plant only label approved crops in treated soils for 18 months.

No. 2: Chloramben at 4 lb./A applied as a single spray immediately after planting.

No. 3: DCPA at 10.5 lb./A applied 4 to 6 weeks after seeding but before weeds emerge following clean cultivation.

No. 4: Dinoseb (ethanol and isopropanolamine salts) at 6 lb./A applied immediately after seeding. Remarks: Do not use on light sandy soil.

Sweet Corn

PROBLEM: Annual and perennial grasses.

TREATMENT: Dalapon at 1.5 lb./A applied as a single directed spray on growing grasses in corn 8 to 10 in. tall. Remarks: Do not use on corn grown for seed.

PROBLEM: Emerged broadleaf weeds.

TREATMENT:

No. 1: 2,4-D (amine salt) at 1.5 lb./A applied on the soil before weeds and crop emerges on heavy soils; or 0.75 lb./A applied as a directed spray on weeds before tasseling of crop; or 0.42 lb./A applied as a directed spray on weeds after corn reaches early dough stage.

No. 2: Linuron at 1.5 lb./A applied as directed spray on emerged weeds in growing corn. Remarks: Do not plant treated areas to crops not approved on label for 4 months.

PROBLEM: Germinating annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Alachlor at 4 lb./A applied before emergence of crop and weeds.

No. 2: Ametryne at 2 lb./A applied after crop emerges but before weeds emerge. Southeastern and South Central States only.

No. 3: Atrazine at 2 to 4 lb./A applied in fall or spring before planting, immediately after planting, or as a directed spray 3 weeks after emergence of crop but before weeds emerge. Remarks: Do not plant treated areas to any crop except corn or sorghum for one year after treatment. Do not graze or feed forage from treated areas to livestock for 21 days after treatment.

No. 4: Butylate at 4 lb./A applied as a soil incorporated treatment before planting.

No. 5: CDAA at 5 lb./A applied immediately after planting.

No. 6: CDEC at 6 lb./A applied immediately after planting.

No. 7: DCPA at 10.5 lb./A applied before weeds and crop emerge.

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- No. 8: Dinoseb (ethanol and isopropanolamine salts) at 4.5 to 9 lb./A applied before weeds and crop emerge.
- No. 9: Dinoseb (amine salts) at 9 lb./A applied immediately after planting.
- No. 10: EPTC at 4 lb./A applied as a soil incorporated treatment 7 to 10 days before planting; or at 3 lb./A as a soil incorporated treatment before weeds or crop emerge. Remarks: Do not use on corn grown for seed.
- No. 11: Linuron at 3 lb./A applied before weeds and crop emerge. Remarks: Plant corn at least 1 3/4 in. deep. Do not plant treated areas to crops not approved on label for 4 months.
- No. 12: Paraquat at 1.0 lb./A applied on emerged weeds before planting; or on emerged weeds before crop emerges.
- No. 13: Prometryne at 3 lb./A applied before weeds and crop emerge. Remarks: Do not plant to any crop but corn in following year.
- No. 14: Prometryne at 5 lb./A applied immediately after planting. Remarks: Do not plant to any crop except corn in the following year.
- No. 15: Propachlor at 6 lb./A applied immediately after planting; or applied as a single spray immediately after crop emerges and before weeds reach 2-leaf stage.
- No. 16: Simazine at 4 lb./A applied in the fall and plow just before planting; or applied before weeds and crop emerge. Remarks: Do not plant treated soil to any crop not approved on the label. Do not graze treated areas.

Sweet Potatoes

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Chloramben at 4 lb./A applied as a single spray immediately before transplanting.
- No. 2: CDAA at 4 lb./A applied immediately after transplanting in Louisiana only.
- No. 3: DCPA at 10.5 lb./A applied immediately after transplanting and repeated after last clean cultivation, up to 6 weeks after transplanting.
- No. 4: Diphenamid at 6 lb./A applied immediately after bedding and after transplanting. Remarks: Do not plant treated soils with crops not approved on the label.

No. 5: EPTC at 3 lb./A applied as soil incorporated treatment immediately before transplanting; or 7.5 lb./A applied as a soil surface treatment within 2 days after transplanting.

No. 6: Vernolate at 1.5 to 3 lb./A applied as soil incorporated treatment immediately before transplanting.

Tomatoes

PROBLEM: Emerged weeds.

TREATMENT: Paraquat at 1.0 lb./A applied on growing weeds before planting; or applied on emerged weeds before crop emerges in direct-seeded plantings.

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 4 to 6 lb./A applied as soil incorporated treatment once annually before seeding or transplanting; or as a soil surface treatment once annually followed by sprinkler or furrow irrigation before seeding or transplanting. Remarks: Plant treated soils only with label approved crops for 18 months after last treatment.

No. 2: CDAA at 6 lb./A applied as granule formulation 2 days after transplanting in Indiana and Michigan only.

No. 3: CDAA at 3 lb./A applied in combination with CDEC at 3 lb./A before weeds and direct seeded crop emerge.

No. 4: CDEC at 6 lb./A applied immediately after direct seeding or immediately after transplanting. Remarks: Do not use on Florida sands.

No. 5: Chloramben at 4 lb./A applied as a granular formulation before weeds emerge 3 to 30 days after transplanting or after last clean cultivation.

No. 6: DCPA at 10.5 lb./A applied following clean cultivation 4 to 6 weeks after transplanting.

No. 7: Diphenamid at 5 to 6 lb./A applied and soil incorporated before weeds and direct seeded crop emerge; or after seeded crop emerges but before weeds emerge; or immediately before or within 4 weeks after transplanting.

No. 8: Methyl bromide at 2 lb./100 sq. ft. applied before seeding on plant bed soils only where plants will be removed for transplanting.

No. 9: Nitralin at 0.5 to 1.5 lb./A applied as a soil incorporated treatment 0 to 6 weeks before transplanting; or immediately after transplanting.
Remarks: Do not plant treated areas to crops not approved on label for 1 year.

No. 10: Pebulate at 6 lb./A applied as soil incorporated treatment immediately before; or as a directed spray at 6 lb./A after transplanting following lay-by cultivation.

No. 11: Trifluralin at 0.5 to 1.0 lb./A applied as soil incorporated treatment immediately before transplanting; or as a directed soil incorporated spray after blocking of direct seeded plantings.

Turnips

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDEC at 4 lb./A applied immediately after planting.

No. 2: DCPA at 10.5 lb./A applied immediately after planting.

Turnip Greens

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: CDEC at 4 lb./A applied immediately after planting.

No. 2: DCPA at 10.5 lb./A applied before emergence of crop and weeds.

No. 3: Trifluralin at 0.75 lb./A applied as a soil incorporated treatment before planting.

Watermelons

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bensulide at 4 to 6 lb./A applied as a soil incorporated treatment before planting. Remarks: Plant only label specified crops on treated land for 18 months after treatment.

No. 2: CDEC at 4 lb./A applied immediately after planting.

No. 3: Naptalam at 3 lb./A applied before emergence of crop and weeds.

No. 4: Nitralin at 0.75 lb./A applied before emergence of crop and weeds.

Deciduous Tree Fruit and Nut Crops

Many different cultural methods and combinations of methods are used in deciduous tree fruit and nut crop production. Principle among these are sod culture, strip sod and cultivation, and clean cultivation.

Herbicides are being used effectively in plantings of many of these crops. In certain of the nut crops, bare soil culture is maintained to control perennial woody and annual herbaceous weeds not controlled by mowing. Clean cultivation may be conveniently combined with herbicide treatments to control germinating weed seeds and sprouting perennial weeds so as to extend the periods between cultivations and thereby minimize root and trunk injury.

Examples of herbicides that have proved useful on deciduous tree fruit and nut crop plantings in some regions are presented here. They indicate the general areas and usefull rates of herbicides for these crops. Specific rates and methods for safe and effective local use are available from weed research specialists in State agricultural experiment stations. Tolerance levels for the various herbicides mentioned are presented in the Appendix.

Tree Fruits

Apples

PROBLEM: Woody brush and perennial herbaceous weeds.

TREATMENT:

No. 1: AMS at 57 lb./100 gal. of water applied as a spot spray to thoroughly wet weed foliage or applied as crystals or concentrated solution on freshly cut stumps of brush plants.

No. 2: 2,4-D(amine salts) at 2 lb./A applied as a single spray on foliage of young actively growing brush and weeds.

PROBLEM: Annual and perennial weed grasses.

TREATMENT: Dalapon at 7.4 lb./A on grass foliage during its rapid vegetative growth in orchards established 4 years or more. Remarks: Do not graze treated areas.

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Dichlobenil at 6 lb./A applied as a single directed spray per year to soil before weeds emerge in established orchards. In new plantings, apply 4 weeks after transplanting.

No. 2: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 1.9 lb./A applied as a single directed spray on weed foliage. Remarks: Do not graze treated area.

- No. 3: Diuron at 3.2 lb./A applied as a single directed spray on soil before weeds emerge during spring (March-May) in orchards established at least one year. Remarks: Do not treat dwarf varieties. Do not replant treated areas to any crop within 2 years after last application.
- No. 4: Diuron at 3.2 lb./A applied as a single directed spray per year to soil before weeds emerge in the far West in winter (December-February) in orchards established at least one year. Remarks: Do not treat dwarf varieties. Do not replant treated areas to any crop within 2 years after last application.
- No. 5: Paraquat at 1 lb./A applied as a single directed spray on foliage of growing weeds. Remarks: Do not allow spray to contact foliage, fruit, or trunks of trees. Do not graze treated areas.
- No. 6: Simazine at 4 lb./A applied as a single directed spray per year on soil before weeds emerge in orchards established at least one year. Remarks: Avoid spray contact with foliage or fruit of trees.
- No. 7: Terbacil at 3.2 lb./A applied as a single directed spray per year on soil before weeds emerge in orchards established at least 3 years. Remarks: Do not replant treated area to any crop within 2 years after last application. Avoid contact with fruit, foliage, or trunks of trees.

Apricots

PROBLEM: Annual and perennial weed grasses.

TREATMENT: Dalapon at 5.2 lb./A applied in Western areas only as a directed spray on foliage of actively growing grasses before seed heads appear. Remarks: Do not allow spray to contact fruit of foliage of trees. Do not apply within 30 days before harvest. Limit treatments to two per season. Do not graze treated areas.

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 1.9 lb./A applied as a single directed spray on weeds and ground cover. Remarks: Do not graze treated areas.
- No. 2: Paraquat at 1 lb./A applied as a single directed spray on weed foliage. Remarks: Do not allow spray to contact fruit, foliage, or trunks of trees. Do not graze treated areas.
- No. 3: Petroleum solvent at 100 gal./A applied as a directed spray on foliage of small rapidly growing weeds. Remarks: Do not allow spray to contact fruit, foliage, or trunks of trees.

No. 4: Trifluralin at 1 lb./A applied as a single soil incorporated treatment disked in immediately after application just before making new plantings.

No. 5: Trifluralin at 2 lb./A applied to the soil as a single treatment per year before making new plantings and incorporated immediately by disking.

No. 6: Trifluralin at 2 lb./A applied to the soil as a single directed spray per year and immediately incorporated by disking or rotary tilling in established orchards.

Peaches

PROBLEM: Annual and perennial weed grasses.

TREATMENT:

No. 1: Dalapon at 2.6 lb./A applied as a directed foliage-wetting spray on grasses before heading in orchards in all areas except the West.
Remarks: Do not graze treated areas. Do not spray within 30 days of harvest. Limit to 2 applications per season.

No. 2: Dalapon at 5.2 lb./A applied as a directed spray to wet the foliage of grasses before heading. Use at this rate in the West only. Remarks: Do not graze treated areas. Do not spray within 30 days before harvest. Limit to 2 applications per year.

PROBLEM: Control of annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Dichlobenil at 6 lb./A applied once annually as a granular formulation or as a single directed spray to the soil 4 weeks after transplanting or in established orchards. Remarks: Do not graze treated areas. Do not treat within 30 days before harvest.

No. 2: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 1.9 lb./A applied as a single directed spray to small weeds and ground cover in orchards. Do not graze treated areas.

No. 3: Dinoseb (ethanol and isopropanolamine salts) at 10.5 lb./A applied as a directed spray on the foliage of small weeds and ground cover.
Remarks: Apply only during crop dormancy. Do not graze treated areas.

No. 4: Diphenamid at 4 lb./A on light soils (6 lb./A on heavy soils) applied as a single spray on the soil before weeds emerge. Remarks: Do not graze treated areas.

- No. 5: Paraquat at 1 lb./A applied as a single directed spray on the foliage of weeds and ground cover. Remarks: Do not allow spray to contact fruit, foliage, or trunks of trees. Do not graze treated areas.
- No. 6: Petroleum solvents at 100 gal./A applied as a directed spray on the foliage of small weeds. Remarks: Avoid contact of spray with foliage or trunks of trees.
- No. 7: Simazine at 2 to 4 lb./A applied as a single directed spray per year to the soil before weeds emerge in late fall or early spring. Remarks: Limitations for use of simazine in peach plantings in the various geographic areas are specifically outlined on the manufacturer's label.
- No. 8: Terbacil at 3.2 lb./A applied as a single directed spray per year to soil before weeds emerge in the spring in orchards established at least 3 years. Remarks: Avoid spray contact with fruit, foliage, or trunks of trees. Do not replant any treated soils with any crop within 2 years after last treatment.
- No. 9: Trifluralin at 1 lb./A applied as a single treatment to the soil per year and incorporated before making new plantings. Remarks: Use of this treatment restricted to the Western States.
- No. 10: Trifluralin at 2 lb./A applied as a single directed spray per year to the soil and immediately incorporated by disking in bearing and non bearing orchards.

PROBLEM: Annual and perennial weed grasses.

TREATMENT: Dalapon at 5.2 lb./A applied as a directed spray to wet the foliage of grasses before heading. Remarks: To be used at this rate in the West only. Do not graze meat or dairy animals on treated area. Do not spray within 30 days of harvest.

Tree Nuts

Almonds

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Dichlobenil at 6 lb./A applied as a single directed spray on soil at least four weeks after transplanting. Remarks: Do not treat within 30 days before harvest. Do not graze treated areas.
- No. 2: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 1.9 lb./A applied as a single directed spray on small weeds and ground cover. Remarks: Do not graze treated areas.

No. 3: EPTC at 3 lb./A metered into irrigation water before last cultivation. Remarks: Do not apply within 14 days before harvest.

No. 4: Paraquat at 1 lb./A applied as a single directed spray on small weeds and ground cover. Remarks: Do not graze treated areas.

No. 5: Petroleum solvent at 100 gal./A applied as directed spray on small weeds.

No. 6: Simazine at 4 lb./A applied as a single directed spray on soil before weeds emerge in orchards established at least one year.

No. 7: Trifluralin at 1 lb./A applied as a spray to soil and immediately incorporated by disking or rotary tilling before making new plantings.

No. 8: Trifluralin at 2 lb./A applied as a directed spray on soil and immediately incorporated by disking in bearing or non-bearing orchards.

Filberts

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 1.9 lb./A applied as a single directed spray on soil, small weeds, and ground cover. Remarks: Do not graze treated area.

No. 2: Dichlobenil at 6 lb./A applied as a single directed spray on soil before emergence of weeds. Remarks: Do not apply within 4 weeks of transplanting or within 30 days before harvest. Do not graze treated areas.

No. 3: Paraquat at 1 lb./A applied as a single directed spray on emerged weeds and ground cover. Remarks: Do not graze treated areas.

Pecans

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Dichlobenil at 6 lb./A applied as a single directed spray on soil before the emergence of weeds at least 6 months after transplantings. Remarks: Do not apply within 6 months after transplanting or 30 days before harvest.

No. 2: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 1.9 lb./A applied as a single directed spray on soil, small weeds, and ground cover. Remarks: Do not graze treated areas.

- No. 3: Trifluralin at 1 lb./A applied as a spray on soil before making new plantings and immediately incorporated by disking or rotary tilling.
- No. 4: Trifluralin at 2 lb./A applied on soil as a single directed spray and immediately incorporated by disking or rotary tilling in bearing or non-bearing orchards.

Walnuts, English

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Dichlobenil at 6 lb./A applied as a single directed spray applied to soil before emergence of weeds. Remarks: Do not treat within 30 days after transplanting or later than 30 days before harvest. Do not graze treated areas.
- No. 2: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 1.9 lb./A applied as a single directed spray on soil, small weeds, and ground cover. Remarks: Do not graze treated areas.
- No. 3: Diuron at 4 lb./A applied as a single directed spray on soil before weeds emerge in late fall or early winter in orchards established at least one year. Remarks: Do not graze treated areas. Do not replant to any crop within 2 years of last application.
- No. 4: EPTC at 3 lb./A metered into irrigation water before last cultivation. Remarks: Use limited to Pacific Northwest, California and Arizona.
- No. 5: Paraquat at 1 lb./A applied as a single directed spray on small weeds and ground cover. Remarks: Do not graze treated areas.
- No. 6: Petroleum solvents at 100 gal./A applied as a directed spray on small weeds.
- No. 7: Simazine at 5 lb./A applied as a single directed spray on soil before weeds emerge in established orchards.
- No. 8: Trifluralin at 1 lb./A applied as a spray on soil before making new plantings and incorporated immediately by disking or rotary tilling.
- No. 9: Trifluralin at 2 lb./A applied on soil as a single directed spray and immediately incorporated by disking or rotary tilling in bearing or non-bearing orchards.

Small Fruits

Small fruits include canefruits, cranberries, grapes and strawberries. Highly specialized weed control methods are required because of the perennial nature of these crops and their different growth habits. Therefore, many weed species must be controlled in summer and winter in many production areas.

Living parts of these crop plants are above ground at all times. It is, therefore, a general practice to use directed, coarse, low-pressure sprays that avoid herbicide contact with the crop wherever possible. In some instances it is possible to use granular herbicides to avoid close, continued contact of the herbicide with the crop. In some crops, such as cranberries and strawberries, the use of directed sprays is not possible. Highly selective herbicides including granular formulations are most useful in these crops.

Examples of herbicides that have proved useful in small fruit plantings in some production areas are presented here. They indicate the general areas and useful rates of application for these crops. Specific rates and methods for safe and effective local use are available from weed research specialists in the State agricultural experiment stations. Tolerance levels for the various herbicides mentioned are presented in the Appendix.

Blackberries

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Chlorpropham at 6 lb./A applied as a single directed spray on the soil before weeds emerge in the dormant crop.

Remarks: Chlorpropham controls germinating annual grasses and chickweed and controls growing chickweed.

No. 2: Diuron at 3.2 lb./A applied as a single directed spray on soil before weeds emerge in the dormant crop established at least one year.

Remarks: Controls most germinating broadleaf weeds and weed grasses. Do not replant treated soil to any crop within 2 years after last treatment.

No. 3: Simazine at 4 lb./A applied to the soil as a single directed spray before weeds emerge during crop dormancy. Apply in spring before fruit set or in fall after harvest. Remarks: Controls most germinating annual broadleaf weeds and weed grasses.

Blueberries

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Chlorpropham at 12 lb./A applied as a single directed spray to soil before weeds emerge during crop dormancy. Remarks: Chlorpropham is most effective in controlling germinating annual grasses and chickweed. Controls growing chickweed.
- No. 2: Diuron at 3.2 lb./A applied as a single directed spray on soil before weeds emerge in the dormant crop established at least one year. Remarks: Do not replant to any crop within 2 years after last treatment.
- No. 3: 2,4-D at 3 lb./A applied on growing weeds in fall after low bush crop leaves have dropped and before field is burned over. Repeat in 2 to 3 years. Remarks: 2,4-D is most effective when applied on the rapidly growing weeds.

Boysenberries

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Diuron at 3.2 lb./A applied as a single directed spray to soil in late winter before weeds emerge or as a split application in late fall and early spring. Remarks: Controls most germinating annual broadleaf weeds and weed grasses. Do not replant treated soil to any crop within 2 years of last application.

Cranberries

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Chlorpropham at 20 lb./A applied as a directed spray or as granules to the soil before weeds emerge and after harvesting of the crop (November-December). Repeat in early spring during dormancy of the crop. Remarks: Chlorpropham controls germinating annual grasses and chickweed. It also controls germinating dodder and growing chickweed.
- No. 2: Dichlobenil at 4 lb./A applied as a single granular treatment to soil in spring or a split application 3-6 weeks apart during cool temperature.
- No. 3: Dichlobenil at 6 lb./A as a granular formulation in a single post harvest treatment.
- No. 4: Ferrous sulfate applied at 800 lb./A during spring to midsummer.

- No. 5: Simazine at 4 lb./A applied as a single directed spray to the soil before weeds emerge in the dormant crop in Massachusetts only. Remarks: Controls most germinating annual broadleaf weeds and weed grasses.
- No. 6: Simazine at 2 lb./A applied as a single directed spray on the soil before weeds emerge in the dormant crop in the spring.
- No. 7: 2,4-D at 1 lb./A applied as a single broadcast spray on the foliage of growing weeds up to the white bud stage of the crop. Remarks: Do not apply after first flowers open.
- No. 8: 2,4-D used at 2 lb. in 100 gal. of water applied on weeds with a cloth swab.
- No. 9: 2,4-D at 4 lb./A applied as a single broadcast spray over bog during dormancy after drawing down winter flood or on ice before spring thaw while crop is dormant.

PROBLEM: Annual grasses.

TREATMENT:

- No. 1: Dalapon at 7.4 lb./A applied as a single post harvest, October to early November, directed spray on growing grasses and sedges.
- No. 2: Dalapon at 1.5 lb./A using a swab treatment solution of 2 lb. to 5 gal. of water applied to grasses above vines. Limit to 2 treatments per year. Remarks: Do not apply later than 60 days before harvest.
- No. 3: Dalapon at 14.8 lb./A as a directed ditch and shore spray treatment. Limit to 2 applications between early June and end of July.

Gooseberries

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT: Diuron at 3.2 lb./A applied as a single directed spray on the soil before weeds emerge in the dormant crop established at least 1 year.

Grapes

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Diuron at 4.8 lb./A applied as a single directed spray per year to the soil before weeds emerge or used at 1.6 lb./A as a split application in late fall and repeated in early spring in plantings established at least 3 years. Remarks: Do not replant treated soil to any crop within 2 years of last treatment.

No. 2: Diuron at 5.6 lb./A applied as a single directed spot spray in established plantings on heavy soil. Use not more than once in 4 years.

No. 3: Dinoseb (4,6-dinitro-o-see-butylphenol) at 2.8 lb./A applied as a single directed spray to the soil between rows after harvest or in early spring before bloom. Remarks: Dinoseb spray will kill most young established weeds and many germinating weeds. Avoid spray contact with canes.

No. 4: Simazine at 4.8 lb./A applied as a directed spray to the soil before weeds emerge in late fall after harvest or in early spring in plantings established at least 3 years.

PROBLEM: Annual weed grasses.

TREATMENT: Dalapon at 7.4 lb./A applied as a single directed spray on actively growing grasses in the row. Remarks: Do not apply within 30 days of harvest.

Loganberries

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT: Diuron at 3.2 lb./A applied as a single directed spray to the soil before weeds emerge in late winter or as a split application in late fall and early spring. Remarks: Controls most germinating annual weed grasses and broadleaf weeds. Do not replant treated soil to any crop within 2 years after last treatment.

Raspberries

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Chlorpropham at 6 lb./A applied as a single directed spray to the soil before emergence of weeds during dormancy of established plantings or immediately after making new plantings. Remarks: Controls germinating annual weed grasses and chickweed. Also controls growing chickweed.

No. 2: Diuron at 3.2 lb./A applied as single directed spray to the soil before weeds emerge in the dormant crop in early winter, in plantings established at least one year. Remarks: Controls most germinating annual broadleaf weeds and weed grasses. Do not replant treated soil to any crop within 2 years after last treatment.

No. 3: Simazine at 4 lb./A applied as a single directed spray to the soil before weeds emerge in spring before fruit set or in fall after harvest.

Strawberries

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Chloroxuron at 4 lb./A applied as a broadcast spray application before weeds emerge in the fall after renovation of beds and repeated no later than 60 days before harvest.

No. 2: DCPA at 9 lb./A applied to the soil as a single broadcast overall spray immediately after transplanting.

No. 3: DCPA at 9 lb./A applied as a single broadcast application before first bloom in spring and repeated in fall. Remarks: DCPA should be applied at least one year before or 60 days after harvest.

No. 4: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 1.9 lb./A applied as a directed spray to row middles and bed shoulders during dormancy in November to January in the Northeastern states only. Remarks: Dinoseb spray kills young growing weeds and prevents the emergence of many weed species.

No. 5: Dinoseb (4,6-dinitro-o-sec-butylphenol) at 2.5 lb./A as a single overall spray during crop dormancy in Pacific Northwest only.

Citrus and Subtropical Fruits and Nuts

Citrus and subtropical fruit and nut crops include all citrus crops, avocados, dates, macadamia nuts, pineapples, and many other crops. Weed problems are many and varied because of the wide distribution of these crops, their perennial nature, and the variety of cultural practices used. Weeds waste irrigation water in plantings of many of these crops. Weeds also harbor insects, diseases, nematodes, and rodents that cause severe economic losses. Herbicides used in combination with mechanical cultivation are economical, effective, and convenient to use. In many instances damage caused by close cultivation can be avoided and the periods between cultivations lengthened by using herbicides.

Aromatic oil emulsions have been used effectively for more than 20 years in many citrus orchards in the West without reducing fruit yield and quality or visibly injuring the groves with respect to tree physiology or soil structure. Newer organic chemical herbicides have been developed and are proving useful in areas where oils cannot be used and on weeds not controlled by oils. Many additional promising new herbicides are being investigated for use on these crops.

Examples of herbicides that have proved useful on citrus and subtropical fruit and nut crops in some regions are presented here. They show the general areas of usefulness of herbicides for these crops. Specific rates and methods for safe and effective local use are available from weed research specialists in State agricultural experiment stations.

Herbicide tolerance levels for each crop are given in the Appendix.

Citrus

Grapefruit

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Bromacil at 6.4 lb./A applied to the soil as a directed spray before emergence of weeds in groves established at least 4 years. Remarks: Do not replant treated soil to any crop within 2 years of last treatment.
- No. 2: Dichlobenil at 6 lb./A applied as a directed spray to the soil around the trees before weeds emerge in groves established one year or more.
- No. 3: Diuron at 3.2 lb./A applied as a single directed spray to the soil before weeds emerge in groves established one year or more. Remarks: Apply only one treatment at this rate each year. Do not replant treated areas to any crop within 2 years after treatment.

- No. 4: EPTC at 3 lb./A metered into furrow or flood irrigation water before weeds emerge in bearing groves. Remarks: Do not apply within 15 days of harvest.
- No. 5: EPTC at 6 lb./A applied to the soil as a single directed spray immediately after transplanting. Cultivate herbicide into soil immediately after application. Remarks: Restricted to nursery stock and non-bearing plantings.
- No. 6: Simazine at 4 lb./A applied as a directed spray to the soil before weeds emerge in established orchards in California only.
- No. 7: Simazine 4.8 lb./A applied as a directed spray to the soil before weeds emerge in established groves in Texas only.
- No. 8: Simazine at 9.6 lb./A applied as a directed spray to soil before weeds emerge in the spring (March to April) in Florida only.
- No. 9: Terbacil at 3.2 lb./A applied to the soil as a single directed spray before weeds emerge in groves established at least one year. Remarks: Do not replant treated soils to any non-citrus crop within 2 years after last treatment. Orange and grapefruit transplants may be made in one year.
- No. 10: Terbacil at 6.4 lb./A applied to the soil as a single directed spray before weeds emerge in groves established at least two years in Arizona and California only. Remarks: Do not replant treated soils to any non-citrus crop within 2 years after last treatment. Orange and grapefruit transplants may be made in one year.
- No. 11: Terbacil at 8 lb./A applied as a directed spray to the soil before weeds emerge in spring or early summer in groves established at least two years in Texas only. Remarks: Do not replant treated soils to any crop except grapefruit or orange within 2 years after last treatment.
- No. 12: Terbacil at 4 lb./A applied as a single directed spray to the soil before weeds emerge in early spring or summer in groves established at least two years in Florida only. Remarks: Do not replant treated soils to any non-citrus crop within 2 years after last treatment. Orange and grapefruit transplants may be made in one year.
- No. 13: Trifluralin at 2 lb./A applied as a directed spray to the soil and incorporated by cultivation. Repeat once in 4 to 6 months. Limit to 2 treatments per year.

PROBLEM: Control of annual and perennial grasses.

TREATMENT: Dalapon at 3 lb./A as a directed spray on growing grasses in established groves. Limit to 3 applications per year. Remarks: Dalapon is only effective in the control of grasses when sprayed on the rapidly growing foliage.

Lemon

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

- No. 1: Dichlobenil at 6 lb./A applied as a directed spray on the soil for emergence of weeds before transplanting in new plantations; or as a directed spray on the soil before the emergence of weeds in groves established one year or more.
- No. 2: Bromacil at 6.4 lb./A applied as a directed spray to the soil before the emergence of weeds in groves established at least 4 years. Remarks: Do not replant treated soil to any crop within 2 years after last treatment.
- No. 3: Diuron at 3.2 lb./A applied as a single directed spray each year to the soil before the emergence of weeds in groves established one year or more. Remarks: Do not replant treated area to any crop within 2 years after treatment.
- No. 4: Monuron at 3.2 lb./A applied as a directed spray to the soil before the emergence of weeds in late fall or early winter in established groves.
- No. 5: Monuron at 1.6 lb./A applied as a directed spray on the soil before emergence of weeds in established groves beginning with a late fall application and followed by a single spring application.
- No. 6: Simazine at 1.6 lb./A applied as a directed spray on the soil before the emergence of weeds in the fall in established groves and repeated in the spring. For use in Arizona only.
- No. 7: Simazine at 4 lb./A applied as a directed spray to the soil before weeds emerge in established groves in California only.
- No. 8: Terbacil at 3.2 lb./A applied as a single directed spray on the soil before emergence of weeds in groves established at least one year. Remarks: Do not replant treated soils to any non-citrus crop within 2 years after last treatment. Orange and grapefruit transplants may be made in one year.
- No. 9: Terbacil at 6.4 lb./A applied as a single directed spray to the soil before weeds emerge in groves established at least 2 years. Use in Arizona and California only. Remarks: Do not replant treated soils to any non-citrus crop within 2 years after last treatment. Orange and grapefruit transplants may be made in one year.
- No. 10: Trifluralin at 2 lb./A applied as a directed spray to the soil before weeds emerge and incorporated by cultivation. Repeat once in 4 to 6 months.

Limes

PROBLEM: Control of annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Dichlobenil at 6 lb./A applied as a directed spray to the soil before the emergence of weeds in groves established one or more years.

No. 2: Diphenamid at 6 lb./A applied as a single directed spray to the soil before weeds emerge at anytime following clean cultivation in nonbearing groves.

PROBLEM: Control of annual and perennial grasses.

TREATMENT: Dalapon at 3 lb./A applied as a directed spray on growing grasses in established groves. Limit to 3 applications per year. Remarks: Dalapon is only effective when applied to the foliage of rapidly growing grasses and will not give any results as a soil treatment. Dalapon is not effective in controlling germinating or established broadleaf weeds.

Nectarines

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Dichlobenil at 6 lb./A applied as a directed spray to the soil before emergence of weeds beginning with a single treatment 4 weeks or more after transplanting or at least one month before harvest in established groves.

No. 2: Paraquat at 1 lb./A as a directed spray on the foliage of growing weeds in established groves and new plantings. Remarks: Paraquat is a contact spray which must wet the weed foliage in order to be effective. Paraquat is not effective as a soil treatment applied before weeds emerge.

Oranges

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Bromacil at 6.4 lb./A applied as a single directed spray to the soil each year before the emergence of weeds in groves established 4 years or more. Remarks: Do not replant treated soils to any crop within 2 years after last treatment.

- No. 2: Dichlobenil at 6 lb./A applied as a directed spray to the soil before the emergence of weeds in groves established one year or more.
- No. 3: Diphenamid at 6 lb./A applied as a single directed spray to the soil before weeds emerge following cultivation at anytime in nonbearing groves.
- No. 4: Diuron at 3.2 lb./A applied as a single directed spray to the soil each year before weeds emerge in groves established at least one year.
- No. 5: EPTC at 3 lb./A metered into furrow or flood irrigation water before weeds emerge in bearing groves. Remarks: Do not apply treatments within 15 days of harvest.
- No. 6: EPTC at 6 lb./A applied as a single directed spray to the soil and immediately incorporated as a post transplanting treatment in nurseries or new groves.
- No. 7: Simazine at 9.6 lb./A applied as a single directed spray to the soil before weeds emerge in established groves in Florida only.
- No. 8: Simazine at 1.6 lb./A applied as a single directed spray to the soil before weeds emerge in the fall and repeated in the spring. For use in Arizona only.
- No. 9: Simazine at 4 lb./A applied as a single directed spray to the soil before emergence of weeds in established groves in California only.
- No. 10: Simazine at 4.8 lb./A applied as a single directed spray to the soil before weeds emerge in established groves in Texas only.
- No. 11: Terbacil at 3.2 lb./A applied as a single directed spray to the soil before weeds emerge in groves established at least one year. Remarks: Do not replant treated soils to any non-citrus crop within 2 years after last treatment. Orange and grapefruit transplants may be made in one year.
- No. 12: Terbacil at 6.4 lb./A applied as a single directed spray to the soil before weeds emerge in groves established at least two years. Use in Arizona and California only. Remarks: Do not replant treated soils to any non-citrus crop within 2 years after last treatment. Orange and grapefruit transplants may be made in one year.
- No. 13: Terbacil at 8 lb./A applied as a single directed spray to the soil before weeds emerge in early summer in groves established at least two years. Use in Texas only. Remarks: Do not replant treated soils to any crop except grapefruit or orange within 2 years after last treatment.

No. 14: Terbacil at 4 lb./A applied as a single directed spray to the soil before weeds emerge in early summer in groves established at least two years. Use in Florida only. Remarks: Do not replant treated soils to any non citrus crop within 2 years after last treatment. Orange and grapefruit transplants may be made in one year.

No. 15: Trifluralin at 2 lb./A applied as a single directed spray to soil before weeds emerge and incorporated by cultivation. Repeat treatment once in 4 to 6 months.

PROBLEM: Control of established annual and perennial grasses.

TREATMENT: Dalapon at 3 lb./A applied as a directed spray on the foliage of rapidly growing grasses in established groves. Limit to 3 applications per year. Remarks: Not effective on broadleaf weeds or on a soil treatment for weed grasses.

Tangelos

PROBLEM: Control of annual and broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Diuron at 3.2 lb./A applied as a single directed spray to the soil each year before emergence of weeds in groves established at least one year.

No. 2: Trifluralin at 2 lb./A applied as a single directed spray to soil before weeds emerge and incorporated by cultivation. Repeat treatment once in 4 to 6 months.

Tangerines

PROBLEM: Annual broadleaf weeds and weed grasses.

TREATMENT:

No. 1: Dichlobenil at 6 lb./A applied as a directed spray on the soil before the emergence of weeds in groves established one year or more.

No. 2: Diuron at 3.2 lb./A applied as a single directed spray to the soil each year before emergence of weeds in groves established at least one year.

No. 3: EPTC at 3 lb./A metered into furrow or flood irrigation water before weeds emerge in bearing groves. Remarks: EPTC should not be used within 15 days of crop harvest.

No. 4: Trifluralin at 2 lb./A applied as a single directed spray to soil before weeds emerge and incorporated by cultivation. Repeat treatment once in 4 to 6 months.

PROBLEM: Control of annual and perennial grasses.

TREATMENT: Dalapon at 0.74 lb.to 20 gal. of water used as a spot spray treatment directed on the foliage of the weed grasses in established groves.

Ornamental Plants

Ornamental plants, including shade trees shrubs, herbaceous annuals and perennials, and bulb crops, form the bulk of plant species in horticultural crops. Some ornamental genera include numerous species and many varieties. Weed problems are widely different because of the individual soil, climatic, and cultural requirements of many of these plants. The number of herbicides available for home or other landscaped plantings is limited because many kinds of plants are grown together. Weeds in commercial plantings of individual species or varieties are controlled by mechanical cultivation, hand weeding, herbicides, cultural practices including rotations, and various combinations of these methods.

Ornamental plant families, genera, species, and even varieties respond differentially to herbicides. Great care is therefore necessary in selecting and using herbicides on them. As a result, soil fumigant herbicides are used in many nurseries. Soil fumigant herbicides are applied, kill many annual and perennial weeds, and are dissipated before planting the crops. Most crops can be planted within a few days after fumigants have been used. General use of soil fumigant herbicides is restricted by the cost of material and time required for treatment. Comparatively low-cost selective herbicides are therefore often used to control specific groups of weeds.

Information on specific rates and methods for safe and effective local use is available from weed research specialists in State agricultural experiment stations.

Examples of herbicides that are useful in ornamental plantings in certain regions are:

<u>Ornamental Plant</u>	<u>Herbicides</u>
Ageratum -----	trifluralin
Alyssum -----	DCPA, trifluralin
American elm -----	simazine
Arborvitae -----	chlorpropham, DCPA, diphenamid, NPA, simazine, trifluralin
Ash -----	DCPA, diphenamid
Aster -----	chlorpropham, DCPA, diphenamid, trifluralin
Astilbe -----	chlorpropham
Austrian pine -----	diphenamid, simazine
Azalea -----	CDEC, chlorpropham, DCPA, diphenamid, trifluralin
Babysbreath -----	DCPA
Balsam -----	chlorpropham, diphenamid, simazine, trifluralin
Barberry ---	chlorpropham, DCPA, diphenamid, simazine, trifluralin

Use Pesticides Safely-Follow the Label

Ornamental PlantsHerbicides

Birch -----	chlorpropham, DCPA, diphenamid, trifluralin
Bleedingheart -----	DCPA
Bluebell -----	chlorpropham
Blue spruce -----	diphenamid, simazine
Boxelder -----	simazine
Boxwood -----	chlorpropham, DCPA, diphenamid, simazine, trifluralin
Bushhoneysuckle -----	simazine
Candle larkspur -----	DCPA
Camellia -----	chlorpropham, DCPA, diphenamid
Caragana -----	simazine, trifluralin
Carnation -----	chlorpropham, trifluralin
Cedar -----	chlorpropham, naptalam
Chrysanthemum -----	chlorpropham, DCPA, diphenamid, trifluralin DCPA
Columbine -----	chlorpropham, DCPA
Contoneaster -----	DCPA, diphenamid, simazine
Coralbell -----	chlorpropham, DCPA
Cottonwood -----	DCPA, diphenamid, NPA, trifluralin
Crabapple -----	DCPA
Creeping juniper -----	chlorpropham
Daffodil -----	
Dahlia -----	chlorpropham, DCPA, diphenamid, dinoseb, trifluralin
Delphinium -----	chlorpropham, DCPA
Deutzia -----	DCPA, diphenamid, trifluralin
Dianthus -----	chlorpropham, trifluralin
Dogwood -----	DCPA, diphenamid, simazine, trifluralin
Douglas Fir -----	diphenamid, simazine, trifluralin
Dutch iris -----	chlorpropham, dinoseb
Elm (Am. & Chin.) -----	DCPA
English ivy -----	chlorpropham
Euonymus -----	CDEC, chlorpropham, DCPA, diphenamid, trifluralin
Evening primrose -----	DCPA
Feverfew -----	DCPA
Firethorn -----	diphenamid, trifluralin
Forget-me-not -----	chlorpropham, DCPA, trifluralin
Forsythia -----	chlorpropham, DCPA, diphenamid, trifluralin
Fraser fir -----	simazine
Fuchsia -----	chlorpropham

Use Pesticides Safely-Follow the Label

<u>Ornamental Plants</u>	<u>Herbicides</u>
Gladiolus -----	CDEC, chlorpropham, DCPA, dinoseb, trifluralin
Golden marguerite -----	DCPA
Hemlock -----	chlorpropham, diphenamid, simazine
Holly -----	DCPA, diphenamid, naptalam, trifluralin
Honeylocust -----	diphenamid, simazine
Honeysuckle -----	chlorpropham, diphenamid, simazine, trifluralin
Hydrangea -----	CDEC, chlorpropham, DCPA
Iris -----	CDEC
Juniper -----	CDEC, chlorpropham, DCPA, diphenamid, naptalam, simazine, trifluralin
Lantana -----	DCPA
Laurel -----	chlorpropham, diphenamid, trifluralin
Lilac -----	chlorpropham, DCPA, diphenamid, dinoseb, naptalam, trifluralin
Lily -----	chlorpropham, dinoseb
Locust -----	DCPA, diphenamid, trifluralin
Lupine -----	DCPA
Magnolia -----	chlorpropham, DCPA
Mahonia -----	chlorpropham, simazine
Maple -----	chlorpropham, DCPA, diphenamid, naptalam, trifluralin
Marigold -----	DCPA, diphenamid, trifluralin
Mockorange -----	chlorpropham, DCPA, diphenamid, trifluralin
Moss rose -----	DCPA
Mourning bride -----	DCPA
Mourning pinks -----	DCPA
Mugo pine -----	simazine
Narcissus -----	chlorpropham, dinoseb
Norway spruce -----	diphenamid, simazine, trifluralin
Oak -----	DCPA, diphenamid
Osmanthus (hollyolive) -----	trifluralin
Pachistima -----	DCPA
Pachysandra -----	chlorpropham
Peony -----	chlorpropham, DCPA
Periwinkle -----	chlorpropham, trifluralin

Ornamental PlantsHerbicides

Petunia -----	DCPA, diphenamid, trifluralin
Picea -----	naptalam
Pine -----	chlorpropham, DCPA, diphenamid, naptalam, trifluralin
Pittosporum -----	DCPA
Plum -----	chlorpropham, naptalam
Podocarpus -----	DCPA
Pokerplant -----	DCPA
Poplar -----	chlorpropham, DCPA, diphenamid
Potentilla -----	CDEC
Privet -----	CDEC, chlorpropham, DCPA, diphenamid, dinoseb, neburon, NPA, trifluralin
Purple coneflower -----	DCPA
Pyracantha -----	diphenamid
Redcedar -----	diphenamid, simazine, trifluralin
Red oak -----	diphenamid, simazine
Red pine -----	diphenamid, simazine
Red spruce -----	simazine
Rhododendron -----	chlorpropham, DCPA, diphenamid, NPA, trifluralin
Rose -----	chlorpropham, DCPA, diphenamid, trifluralin
Russian olive -----	DCPA, simazine
Salvia -----	DCPA, diphenamid, trifluralin
Scarlet sage -----	DCPA
Scotch pine -----	diphenamid, simazine
Siberian elm -----	simazine
Snapdragon -----	DCPA, diphenamid, trifluralin
Spirea -----	CDEC, chlorpropham, DCPA, diphenamid, dinoseb, trifluralin
Spruce -----	chlorpropham, DCPA, diphenamid, NPA, trifluralin
Tulip -----	chlorpropham, dinoseb
Tulip tree -----	DCPA, diphenamid
Variegated privet -----	DCPA
Verbena -----	DCPA
Viburnum -----	chlorpropham, DCPA, diphenamid, trifluralin
Wiegela -----	DCPA, diphenamid, trifluralin
White cedar -----	simazine
White pine -----	diphenamid, simazine
White spruce -----	diphenamid, simazine
Willow -----	DCPA, diphenamid, trifluralin

Ornamental PlantsHerbicides

Wintercreeper ----- chlorpropham

Yew ----- CDEC, chlorpropham, DCPA, diphen-
amid, dinoseb, nuburon, NPA,
simazine, trifluralin

Zinna ----- DCPA, diphenamid, trifluralin

FORAGE CROPS

Methods of weed control included are those found by research to be effective. Because changes in registration of herbicide uses are frequently made, it is the user's responsibility to confirm whether or not herbicide uses are included on the labels of the herbicides being considered.

Because most forage crop seedlings grow slowly, they are especially susceptible to weed competition and they often fail to become established because of heavy weed infestations. Especially difficult to control are infestations of perennial weeds such as quackgrass, nutsedge, Canada thistle, and johnsongrass. Stands of these often need to be reduced in the rotation crops before seeding the forage crop is attempted.

The difficulty of controlling weeds, once they are introduced, should motivate farmers to buy weed-free seed for planting. For instance, dodder is an especially troublesome parasitic weed because its seed persists in the soil for many years. Other weeds, such as quackgrass and johnsongrass, because of their strong vegetative-spreading characteristics, may gradually take over the crop. Also, winter annual weeds become established during the fall and winter when the forage crops are growing slowly or are dormant. These provide strong competition in the spring and lower the quality of the first hay crop of the season.

Any practice that promotes greater vigor of seedlings or established forage crop plants will render it more competitive with weeds, if the weeds are not similarly stimulated. In northeastern United States, several states report greater seedling growth of alfalfa when P and K were banded 1 to 2 inches below seed sown 0.25 to 1 inch deep. Others have found that additions of ammonium nitrate to seedling alfalfa favored annual weeds, thus leading to decreased alfalfa yields.

The widespread practice of growing seedling forage legumes with a companion crop modifies the spring weed problem. The use of a companion crop, such as small grains and early canning peas, is essentially substituting crop competition for weed competition. However, the crop may be removed for hay or canning early enough in the season to allow good recovery of the seedling legumes. This is economically advantageous in some geographic locations. However, dense or lodged companion crops may cause severe losses of legume stand.

Some weed species are favored by the same conditions responsible for vigorous growth of forage plants; for example, curly dock and chickweed are favored in high fertility soils in humid regions.

Woody plants tend to dominate the vegetation where they are growing and must be removed to achieve efficient production of forage. Most woody plants will not be controlled by ordinary management practices. In addition, many persistent perennial weeds will not succumb to the known agronomic practices within a reasonable time. Mechanical methods are sometimes used to control woody weed species.

Fortunately selective herbicides are now available that will aid in dealing with many of these problems. By killing unwanted species, they may hasten the succession to more desirable plants. By selective control of the undesirable species, along with improved grazing practices, the recovery of native forage plants and other desirable species may be hastened. Because many pastures and rangelands are so depleted of desirable species, a long time would be required for natural succession to take place if only improved grazing management is practiced. Here seeding adapted forage species may be necessary.

For additional information on the control of many range weeds, see the un-numbered publication on "Chemical Control of Range Weeds," U.S. Department of Agriculture and U.S. Department of the Interior, issued December 1966. The relative susceptibility of many weeds to 2,4-D, MCPA, 2,4,5-T, silvex, and 2,4-DB is tabulated in Farmers' Bulletin 2183, "Using Phenoxy Herbicides Effectively."

See list of metric equivalents for weight, volume, area, and linear dimensions in the appendix.

Alfalfa and Birdsfoot Trefoil

New Seedings (no companion crop)

PROBLEM: Weed grasses in new seedings.

TREATMENT: EPTC, 2-4 lb./A, and benefin, 1.1-1.5 lb./A, applied preplanting and incorporated into the soil immediately by disking, rotary hoeing, harrowing, or other similar methods. Remarks: Effective on seedling grasses. Temporary stunting of growth of alfalfa seedlings and malformations of leaves sometimes result from using EPTC.

PROBLEM: Broadleaf annual weeds in new seeding.

TREATMENT:

No. 1: EPTC, 2-4 lb./A, and benefin, 1.1-1.5 lb./A applied preplanting and incorporated into the soil immediately. Marginally effective on broadleaf annual weeds; postemergence treatment of 2,4-DB, ester or amine salt formulations at 1 to 1.5 lb./A, respectively, when weeds are about 3 in. or less in height, kills most broadleaf weed species with only minor stunting of alfalfa and birdsfoot trefoil. The registration of 2,4-DB for this use specifies that grazing should be deferred and hay not be cut from treated fields within 30 days after treatment. Some mustard species and chickweed are not effectively controlled.

No. 2: The contact herbicide, dinoseb, at 0.75 to 1.5 lb./A in 20 to 40 gal. water/A, when legume seedlings have two or more true leaves and when weeds are 1 to 2 in. tall, kills most broadleaf weed species but not grasses with only minor injury to alfalfa. Serious injury to birdsfoot trefoil sometimes results. The higher the temperature, the more effective the dinoseb treatment, but also, the selectivity of dinoseb is reduced. Registration of dinoseb for this use specifies: "Do not graze livestock on treated fields for feed forage within 60 days after treatment."

PROBLEM: Mixture of weed grasses and broadleaf weeds in new seedlings.

TREATMENT: Preplanting application of EPTC, incorporated into the soil immediately, at 2-4 lb./A, followed by a postemergence treatment of 2,4-DB at 1 to 1.5 lb./A, controls both seedling grasses and broadleaf weeds; similarly effective treatment involved the combination of preplanting application of benefin, immediately incorporated in the soil, at 1.1-1.5 lb./A followed by the postemergence treatment of 2,4-DB. The same preplanting, soil incorporated treatments, in combination with postemergence application of dinoseb when weeds are less than 2 in. tall, are effective on alfalfa but may injure birdsfoot trefoil seedlings.

Established Stands

PROBLEM: Downy brome grass and other annual weeds in Northwestern States in crops established one year or more.

TREATMENT: Diuron at 1.5-2 lb./A in the fall after the crop is dormant or in early spring. Do not replant treated areas of alfalfa to any crop within 2 years after treatment and within 1 year after treatment of Birdsfoot trefoil (use restricted to western Oregon). Remarks: Refer to label for full instructions, restricted geographic areas, and crops and where this treatment can be used.

PROBLEM: Henbit, yellow rocket seedling, chickweed, and other winter annual weeds.

TREATMENT: Dinoseb (triethanolamine salt) 0.75 to 1.5 lb./A. Time of Treatment: In the fall when legumes are dormant and weeds are small with retreatments in late winter or early spring being necessary for heavy infestations. Remarks: Do not spray when crop is wet. Apply when temperatures are about 50° F or higher. Do not graze livestock on treated fields before first cutting. Consult label.

PROBLEM: Annual weeds and grasses in the dormant season.

TREATMENT: Simazine at 0.8 to 1.6 lb./A in the fall before killing frost but before January 1. Remarks: Legume stand must be at least one year old. Recommendations for specific areas vary; therefore, labels should be consulted. These treatments are useful only in areas where alfalfa goes dormant and where frost occurs. Legumes should
Use Pesticides Safely-Follow the Label

not be grazed within 30 days or cut for hay within 60 days of treatment.

PROBLEM: Sensitive broadleaf weeds.

TREATMENT: 2,4-D or MCPA at 0.1 to 0.25 lb./A applied at the early dormant stage of the legume. Remarks: These treatments should be used as emergency measures only if weed infestation threatens loss of the crop.

Pastures and Grass Seed Fields (New Seedlings)

PROBLEM: Perennial weeds, such as bermudagrass, Canada thistle, johnsongrass, and quackgrass.

TREATMENT: Summer fallow for one full growing season before planting grass to reduce or eradicate the aggressive perennial species. A crop may be grown which tolerates a herbicidal treatment that is effective on a problem species for 1 or 2 years before seeding grass. Consult local authorities.

PROBLEM: Annual broadleaf weeds and annual grasses in new seedlings.

TREATMENT: Thorough tillage in intertilled crops 1 or 2 years preceding the planting of grass may reduce the residual seed supply in the soil and, thus, increase chances of obtaining a good stand of the seeded grasses; where winter annual grasses and other weeds are a problem, delay the date of seeding until after the last hard freeze in the spring. This is practical only in those areas having sufficient rainfall, or irrigation, to establish seedlings of grass before heat and summer drought starts. After seeding, an application of 2,4-D at 0.5 lb./A when broadleaf weeds are about 12 in. tall will control them and result in less weed-grass competition as compared with earlier treatments. Registration of this use specifies: "Do not graze dairy animals on treated areas within 7 days after application."

PROBLEM: Chickweed, henbit, and knotweed in new seedlings.

TREATMENT: Silvex applied at rate of 0.5 lb./A and dicamba applied at the rate 0.25 lb./A. Rates higher than this will injure grasses and should not be exceeded until grasses become well established; 2,4-D, amine salts, at rates of 0.25 to 0.75 lb./A can be used for other susceptible weed species. If tolerant weeds are mixed with susceptible ones, use a mixture of 2,4-D with dicamba. The total rate of treatment with the mixture should not exceed 0.75 lb./A. Remarks: If land is heavily infested with seeds of annual grasses, delay herbicide application until broadleaf weeds are 12-15 in. tall; this, in turn, delays establishment of the weed grasses. Do not add surfactants. Registration specifies: "Do not graze dairy animals on treated areas within 7 days after application." Do not harvest dry hay from treated areas as feed for dairy animals within 37 days after treatment. Do not graze meat animals in treated

fields within 30 days before slaughter.

PROBLEM: Annual broadleaf weeds and weed grasses in sprigged stands of bermudagrass.

TREATMENT: Apply diuron at 0.8 to 2.5 lb./A, or simazine at 1 to 2 lb./A, just before or just after sprigging but before weeds emerge.

Remarks: Use lowest rate of herbicide on sandy soil, intermediate rates on loams, and highest rates on clay soils. Delay grazing for 70 days and hay harvest for 90 days after treatment. Consult label. Injury to subsequent crops in treated areas can occur within 2 years after treatment.

Permanent Pastures and Rangeland

Patures

PROBLEM: Broomsedge in pastures.

TREATMENT: Fertilize at relatively high rate of nitrogen, alone or in a mixed fertilizer. Mow when the grass begins to become coarse and graze pasture intensively. Remarks: Consult local authorities for recommended rates and times of fertilizer application.

PROBLEM: Burdock, Canada thistle, hickory, dandelion, ironweed, pigweed, ragweed, sneezeweed, and tarweed.

TREATMENT: 2,4-D, amine salts or esters, at 0.5 to 1 lb./A, usually in late spring. Remarks: Spray when weeds are actively growing; in humid area where legumes are in the pasture, delay treatments until initial rapid early growth of legumes has passed. Registration of this use specifies: "Do not graze dairy animals on treated areas within 7 days after application."

PROBLEM: Common broomweed, curly dock, horehound, wild garlic, and wild onion.

TREATMENT: Apply 2,4-D ester at 2 lb./A between February and May. Remarks: If second application is necessary, treat between October and December. Treatments should be applied annually until adequate control is attained. Keep dairy animals out of pasture for 7 days after spraying.

PROBLEM: Bedstraw, chickweed, henbit, and knawel.

TREATMENT: Apply 2,4,5-T, amine salts, or silvex at 1 to 2 lb./A in the fall, winter, or spring. Remarks: These herbicides kill lespedeza and seriously injure true clovers. Remove milk cows from pasture for 6 weeks after spraying. Do not graze meat animals on treated areas within 2 weeks of slaughter.

Rangeland

PROBLEM: Yuccas

TREATMENT: Silvex, low volatile ester, 0.75 to 1 lb./A applied May 15 to June 30.

PROBLEM: Shinnery oak.

TREATMENT: Silvex or 2,4,5-T, low volatile esters, at 0.25 to 1 lb./A, applied in the full leaf stage and while plants are growing actively.

Remarks: Tops are killed with one application. To reduce stands, make 2 to 3 annual applications. In drought years, or if foliage has been damaged by frost, defer spraying until next year.

PROBLEM: Downy brome and associated broadleaf weeds, such as Russian thistle, tansy mustard, and tumble mustard.

TREATMENT: Cultivation by dis' harrow or disk plow after emergence of a full stand of weeds in the spring, usually after April 1 in the Temperate Zone. Remarks: Treatment is in preparation for spring seeding or for fallow and fall seeding of perennial grasses, such as crested wheat and intermediate wheatgrass; seeding in furrows will increase chances of seeding success; spring seeding should not be attempted after April 15.

PROBLEM: Big sagebrush, low sagebrush, and sand sagebrush.

TREATMENT: 2,4-D applied at 1.5 to 2 lb./A after spring growth and before soil moisture is depleted in upper 8-10 in. of soil. Remarks: Diesel oil is preferred as a carrier for lowest-gallonage applications of 2,4-D; properly timed mowing also controls big sagebrush and low sagebrush and can be used where terrain is not too rough or rocky.

PROBLEM: Rabbitbrush.

TREATMENT: 2,4-D at 3 lb./A when new twig growth is 3 in. or longer and before soil moisture is depleted in the upper 8 to 10 in of soil. Remarks: More difficult to control than sagebrush. Do not apply when soil moisture is critically low. This treatment is effective on both rabbitbrush and sagebrush.

PROBLEM: Buckbrush.

TREATMENT: 2,4-D esters at 1 to 2 lb./A after full foliage is reached (usually last part of May). Remarks: Repeated annual sprayings may be necessary. Correct timing is important.

PROBLEM: Deathcamus.

TREATMENT: 2,4-D ester at 1.5 to 3 lb./A applied in the early spring when plants are in the 3 to 5 leaf stage. Remarks: Spraying is ineffective if treatment is delayed.

PROBLEM: Low Larkspur.

TREATMENT: 2,4-D esters at 1.5 to 3 lb./A applied when plants are fully emerged but before flower stems appear. Remarks: Do not graze sprayed areas for at least 3 weeks after treatment.

PROBLEM: Tall larkspur.

TREATMENT: 2,4,5-T esters or silvex at 3 to 4 lb./A applied in the late vegetative growth stage but before flower buds are easily visible. Remarks: Repeated annual applications necessary. Do not graze sprayed areas for at least 3 weeks after treatment because of possible increased toxicity of the tall larkspur. Do not graze dairy animals on treated areas for 6 weeks after treatment. Do not graze meat animals on treated areas within 2 weeks of slaughter.

PROBLEM: Locoweed, princesplum, silver lupine, two-grooved milkvetch, water-hemlock, and woody aster.

TREATMENT: 2,4-D ester, 2 lb./A, applied in the bud to early bloom stage. Remarks: Repeated annual applications may be necessary. Do not graze sprayed areas for at least 3 weeks after treatment.

PROBLEM: Tansy ragwort.

TREATMENT: 2,4-D ester at 2 lb./A applied in the early bolting stage.

PROBLEM: Orange sneezeweed.

TREATMENT: 2,4-D esters at 3 lb./A applied in the prebloom stage.

PROBLEM: Halogeton.

TREATMENT: 2,4-D low-volatile esters at 2 lb./A applied in the early branching prebloom stage. Remarks: Provides control for one year. Halogeton reinfests the area the next year unless other plants occupy site. Use to kill halogeton near trails and bed grounds to reduce hazard of poisoning sheep and to protect larger uninfested areas. 2,4-D may also injure broadleaf forage and browse species.

PROBLEM: Timberline milkvetch.

TREATMENT: 2,4,5-T esters at 1 to 2 lb./A applied to actively growing plants in late vegetative or early but stage. Remarks: Do not graze dairy animals on treated areas within 6 weeks after application to avoid residues in the milk. Do not graze meat animals on treated areas within 2 weeks of slaughter.

PROBLEM: Blackjack oak, post oak, and associated species.

TREATMENT: 2,4,5-T esters or silvex at 2 lb./A applied at the full-leaf stage after rapid growth. Retreatments for 2 to 3 consecutive years are required to kill a satisfactory number of trees. Remarks: In Texas, use of 1 to 2 lb. 2,4,5-T plus 0.5 lb. of picloram kills a higher number of the tolerant species, such as winged elm and yaupon, which may be growing with mesquite, post oak, and blackjack oak stands. A second treatment of 2,4,5-T plus picloram may be made after 2 years, if necessary. Do not contaminate water. Do not move treated soil. Do not use around the home, recreational areas, or similar sites. Do not graze dairy animals on treated areas within 6 weeks after application. Do not graze meat animals on treated areas within 2 weeks of slaughter.

PROBLEM: Honey mesquite.

TREATMENT: 2,4,5-T low-volatile esters at the 0.5 lb./A rate 50 to 90 days after the first leaves appear in spring; mixtures of 2,4,5-T and picloram at 0.5 lb. of each per acre have been somewhat more effective in Texas than either herbicide alone. Remarks: Most tops are killed but only a low percentage of the plants are killed by 2,4,5-T. Retreatment is necessary in 5 to 7 years. Do not graze dairy animals on treated areas for 6 weeks after treatment. Do not graze meat animals on treated areas within 2 weeks of slaughter.

PROBLEM: Velvet mesquite.

TREATMENT: 2,4,5-T low-volatile esters at 0.3 to 0.5 lb./A applied after leaves are full size and the terminal elongation of stems has stopped. Remarks: Retreat within 2 years. Do not graze dairy animals on treated areas for 6 weeks after treatment. Do not graze meat animals on treated areas within 2 weeks of slaughter.

PROBLEM: Agarita, catclaw, elbowbush, huisache, and mesquite.

TREATMENT: Basal stem treatment of 2,4,5-T low-volatile esters 8 lb./100 gal. diesel oil applied to frills, stumps, or basal trunks when the soil is dry. When the Acacia species occur with mesquite in Texas, foliage treatments of a mixture of 2,4,5-T and picloram as shown above have been effective.

PROBLEM: Ash, blackgum, blackjack oak, burroweed, Baccharis, bayberry, beech, birch, Ceanothus, chestnut, chinkapin, cottonwood, elm, hackberry, hickory, honeylocust, hydrangea, madrone, manzanita, mescalbean, mulberry, narrowleaf spirea, osageorange, pecan, pin oak, post oak, pricklyash, red haw, red maple, red oak, retama, sassafras, silver maple, spicebush, sumac, sweetgum, sycamore, tree-of-heaven, walnut, water oak, white oak, wild chinaberry, willow, and willow oak.

TREATMENT: 2,4,5-T low-volatile esters 12.0 to 20.0 lb. in 100 gal. diesel oil applied as a basal spray in summer or winter. Remarks: Solution should be applied to the base of small trees and in frills or to the freshly cut stumps of larger trees. Enough volume should be applied to cause some rundown of the spray on the bark.

PROBLEM: Hardwood species more than 1 in. in diameter.

TREATMENT: Low-volatile esters of 2,4,5-T at 12.0 to 20.0 lb./100 gal. of diesel oil applied by tree injector or other injecting equipment. The application is made in cuts 2 in. apart at the base of the tree.

PROBLEM: Cholla cactus, pricklypear, and tasajillo.

TREATMENT: 2,4,5-T or silvex low-volatile esters at 8.0 lb./100 gal. of diesel oil applied as a wetting spray when plants are growing rapidly; pricklypear can be killed by dragging or rolling the plants before applying the foliage spray of 4 lb. of silvex in diesel oil. Remarks: Do not graze dairy animals on treated areas within 6 weeks after application. Do not graze meat animals on treated areas within 2 weeks of slaughter.

WEED CONTROL IN LAWNS AND OTHER ORNAMENTAL TURF AREAS

Good turf care, including proper liming, fertilization, watering, proper height and time of cutting, and control of insects and diseases, should accompany any program of weed control in lawns and other turf areas. Controlling weeds without correcting other lawn management problems will usually be disappointing. Vigorous turf is required to fill in the bare spots remaining after weeds are controlled. In addition, a vigorous dense turf will greatly aid in preventing reinfestation.

Herbicides may be used to control weeds in lawns and other turf areas. Follow explicitly all directions on the container label. For further information on controlling lawn weeds with herbicides and for data on the susceptibility of many lawn weeds to phenoxy herbicides, see U.S. Department of Agriculture Home and Garden Bulletin 123, "Lawn Weed Control with Herbicides," and Farmers' Bulletin 2183, "Using Phenoxy Herbicides Effectively."

New Seedings

PROBLEM: Seedbed areas infested with weed seeds or plant parts of the weed grasses and broadleaf weeds.

TREATMENT: Methyl bromide at 1.0 lb./100 sq ft applied with a special applicator under a gastight cover. Treatment should be made when soil temperature is above 65° F. Treatments should be applied to well-prepared moist seedbeds. Cover should remain in place for at least 24 hours. Manufacturer's instructions should be carefully followed.
Remarks: This soil fumigant is a deadly poison. Follow the directions on the label. The lawn may be seeded 2 to 3 days after cover is removed.

PROBLEM: Crabgrass, foxtail, and barnyardgrass in spring seedings.

TREATMENT: Siduron at 0.25 lb./1,000 sq ft (10.0 lb./A) applied immediately before, during, or after seeding. It is advisable to water within 3 days if no rain occurs. Use on bluegrass and fescue turf. Some strains of bentgrass are also tolerant of siduron, others are not.
Remarks: Siduron is the only herbicide sufficiently selective to control crabgrass, etc., in new seedings of bluegrass.

PROBLEM: Broadleaf weeds in new seedings.

TREATMENT: After grasses have reached mowing height, 2,4-D at 0.5 lb./A or dicamba at 0.25 lb./A can be used alone or in mixtures at a total rate of 0.75 lb./A. This rate will stunt the growth or control many species with only minor injury to the grass. If knotweed and red sorrel are present, they will be killed by inclusion of dicamba at not more than 0.25 lb./A in the mixture. Remarks: Treatment may injure bentgrass, St. Augustine grass, dichondra, and clover lawns.

Established Lawns

PROBLEM: Crabgrass

TREATMENT: (Should be applied before crabgrass emerges) benefin at 1.5 to 3.0 lb./A depending on soil texture, bensulide at 10.0 to 15.0 lb./A, terbutol at 10.0 to 15.0 lb./A, and siduron at 10.0 lb./A. Remarks: In the spring, date of crabgrass emergence is later in the North than it is in the South. A good time to apply the preemergence herbicide is at the end of flowering of forsythia when the flowers are falling off the plants. Of the herbicides effective for pre-emergence control of crabgrass, only siduron can be used at the time of or a short time before seeding turfgrass species. A waiting period of 3 to 6 months following application of the other pre-emergence herbicides is necessary if injury to new seedlings is to be avoided from herbicide residues in the soil. Homeowners should read the directions on the label carefully before making treatments. Most labels indicate the number of square feet that a package will cover.

PROBLEM: Clumps of nimblewill, orchardgrass, quackgrass, and timothy.

TREATMENT: Spot treatment, when grasses are actively growing, with dalapon at 0.25 lb. in 1.0 gal. of water/1,000 sq. ft. Treatment will injure all grass in treated spot and usually for a small distance beyond the treated spot. Carefully treat the weeds. If applied to warm moist soil, it is possible to reseed the spots in 3 to 6 weeks. Spot treatment with undiluted stoddard's solvent is also effective.

PROBLEM: Bermudagrass in cool-season turf species.

TREATMENT: Apply dalapon at 0.25 lb. in 1.0 gal. of water/1,000 sq. ft. in July. Repeat the treatments 5 to 6 weeks later. Keep area well watered between applications. Metham (SMDG) at 0.5 lb./1,000 sq. ft. in early August. Repeat 4 to 6 weeks later. Remarks: Dalapon kills all the lawn grasses in the treated area. Reseed the area 3 weeks after the second application if good moisture level has been maintained in the soil and if temperatures are high, 6 weeks if temperatures are low. If soil becomes dry, water thoroughly before seeding. With metham, reseed 3 to 4 weeks after second application. Follow the manufacturer's directions.

PROBLEM: Established crabgrass, dallisgrass, goosegrass, and sandbur.

TREATMENT: DSMA and similar arsonates at 3.0 to 4.0 lb./A. If soil is dry, water 2 to 3 days before treatment. Treatments are most effective when temperatures at 75° F and above. Retreat at 7- to 10-day intervals until control is obtained. Remarks: Follow instructions on the label. Treatment may slightly discolor turf. Do not use on St. Augustine or centipedegrass.

Established Lawns (with Broadleaf Weeds)

PROBLEM: Most broadleaf weeds, such as dandelions and plantain.

TREATMENT: 2,4-D applied when the plants are actively growing in either spring or fall, at rates recommended on the label. Remarks: Use low pressure in sprayer and make applications only when there is almost no wind and stay away from shrubs and other ornamental plants which may be severely injured or killed by minute quantities of spray drift. Usually most satisfactory results are obtained by overall sprays. However, spot treatments may be accomplished by fastening a piece of kitchen sponge to the end of a stick or broom handle. Dip the sponge into the spray solution, prepared as for foliage spraying, and the broadleaf weeds are treated by pressing the moist sponge against the crown of each plant.

PROBLEM: Burclover, chickweed, ground ivy, henbit, pennywort, violet, white clover, and woodsorrel.

TREATMENT: Silvex applied at the rate recommended on the label to the actively growing weeds. Remarks: Follow the same precaution as in spraying with 2,4-D.

PROBLEM: Knotweed, red sorrel, chickweed, clover, henbit, and purslane.

TREATMENT: Dicamba at 0.25 lb./A or as recommended on the label. Remarks: Dicamba is often sold in mixtures with 2,4-D or silvex. Follow the label recommendations. Dicamba is more readily adsorbed by plants from the soil than 2,4-D and silvex, therefore, more care is required not to spray within the "drip line" of ornamental shrubs.

PROBLEM: Wild garlic and wild onion.

TREATMENT: 2,4-D applied at 1.0 and 2.0 lb./A, or according to directions on manufacturer's label, in late winter or early spring each year for 3 or more years. Remarks: Follow the same precautions as above.

PROBLEM: Nutsedge

TREATMENT: 2,4-D applied repeatedly at 2.0 lb./A, or according to directions on manufacturer's label, at about 4 to 6 weeks interval between treatments. When this regime is begun in June of each year and followed for 2 or more years, stands of nutsedge are greatly reduced. The arsonate herbicides such as DSMA when repeatedly applied at 3.0 lb./A, or according to directions on the label, control nutsedge plants. When treatments are begun in late June and repeated at 4 to 6 week intervals greatly reduced stands result. Do not use on St. Augustine grass, bahiagrass, or centipedegrass.

General precautions necessary for all phenoxy compounds (2,4-D, 2,4,5-T, silvex, and MCPA) used in turf situations.

1. "Vapors from the product may injure susceptible plants in the immediate vicinity"(ester formulations only).
2. "Do not contaminate water used for irrigation or domestic purposes."
3. "Do not store near fertilizers, seeds, insecticides, or fungicides."
4. "Thoroughly clean spray equipment with a suitable chemical cleaner before using for other purposes," or "Do not use same spray equipment for other purposes."
5. "Coarse sprays are less likely to drift."
6. "Avoid spray drift to susceptible plants, as the product may injure cotton, beans, peas, grapes, ornamentals, etc."
7. "Do not use 2,4,5-T around the home, recreational areas or similar sites."

WEED CONTROL ON NONCROPLAND

(Fence Rows, Industrial Sites, Road and Utility Rights-of-way, and Banks of Run-off Drainage Ditches)

Construction Aids To Weed Control

Fence rows, industrial sites, road and utility rights-of-way, banks of ditches used to carry rain run-off, and other uncultivated areas should be designed, constructed, and managed in such a way as to enhance efficient vegetation control. Ditchbanks should be shaped to provide uniform crowns and slopes. A roadway should be maintained on one bank or each bank for efficient and economic use of mowers, burners, and spraying machinery. Shaping ditches, grades, and back slopes along highways to avoid steep or irregular contours provides similar advantages. Fencing ditch rights-of-way and providing suitable livestock guards in lieu of gates greatly facilitate livestock grazing for weed control on ditchbanks without restricting the movement of vehicles and equipment.

The use of metal fenceposts and metal or concrete structures in or along ditches and highways greatly facilitates the operation of weed burners and decreases the chance of damage to the posts and structures. Corner posts and utility line poles should be set in concrete when this will eliminate brace rods and wires, which are obstacles to weed-control operations.

Cultural, Biological, and Mechanical Control

Seeding ditchbanks, fence rows, and rights-of-way to adapted species of low-growing grasses or other desirable plants usually provides sufficient competition to reduce greatly the weed problem and increase the effectiveness and economy of grazing, mowing, or selective herbicides used for vegetation control. Establishment of suitable stands of the desired competitive vegetation is much easier on newly constructed ditchbanks or road rights-of-way than on those already heavily infested with weeds. Frequently weed growth can be eliminated by repeated burning or by spraying with a nonpersistent herbicide followed by seeding with grass or other revegetation mixtures. Grazing by livestock can provide effective, economical vegetation control on ditchbanks and floodways if the livestock do not seriously damage the facility. Other than grazing livestock, only a few biological agents effectively control weeds on noncropland. Examples are insects that control Scotch broom, gorse, and St. Johnswort in fence rows and other uncultivated areas.

Repeated mowing or burning with a butane, liquid propane, or petroleum burner tends to eliminate or reduce tall weed species and encourages the dominance of more desirable low-grading vegetation. Mowing or burning must be repeated three to eight times each growing season to maintain effective control of undesirable plants.

See list of metric equivalents for weight, volume, area, and linear dimensions in the appendix.

Use Pesticides Safely-Follow the Label

CONTROL WITH HERBICIDES

Choice of Herbicides and Rates

In choosing a herbicide or a mixture of herbicides and the rate of application for weed control in a noncrop area, the user should consider several environmental and site characteristics. They include (1) the dominant kind of vegetation present--annuals, deep-rooted herbaceous perennials, grasses, broadleaf weeds, mixed vegetation, or woody plants; (2) the objective--total vegetation control (soil sterilization), selective control of broadleaf weeds and tall coarse grasses in short competitive and soil-binding grasses, and control of tall woody plants; (3) the type and fertility of soil--medium loam, heavy clay, or light sandy or gravelly loam with high or low organic matter content; (4) the amount and distribution of precipitation; and (5) the proximity of susceptible crops, ornamentals, or other desirable plants.

Many herbicides that are effective on broadleaf weeds are not effective on weedy grasses and vice versa; but some herbicides are effective on both types. Usually the herbicides that are most soluble in water or oil and are applied in sprays give the most rapid kill of top growth. Herbicides that are less soluble in water usually remain in the soil longer and provide weed control for a longer period. The minimum amount of precipitation required to leach soil-applied chemicals into the soil around weed roots to make the herbicide effective ranges from 2 to 5 inches.

Persistence of a herbicide in soil tends to be longer under conditions of low precipitation, fine or tight texture of soil, low organic content, nonsubmergence by water, and low micro-organism content of the soil. Higher rates of application are usually required on heavy soils, soils high in organic matter, and in regions of abundant precipitation. More frequent application of herbicides may be required to maintain weed control on lighter soils and in areas of high precipitation. Generally, repeated annual applications of soil sterilant herbicides at relatively light rates are more effective and economical than less frequent applications at heavier rates, especially for control of annual and shallow-rooted perennial weeds and seedlings of deep-rooted perennial weeds.

Few chemicals used alone will kill all species of plants under all climatic and soil conditions and at rates that are economical. Mixtures of herbicides with different solubilities in water and different specificities are used much more commonly for complete vegetation control in noncrop areas. Mixtures are being used widely for soil sterilization where the soil is unproductive and remains bare for varying lengths of time. Usually each herbicide component in a mixture is applied at a rate lower than the rate that would be required if it were used alone. The total rate of the mixture is usually less than that of the major component herbicide if used alone. The herbicides most commonly used in mixtures are sodium borates, sodium chlorate, simazine, and the phenylurea compounds. However, most of the other herbicides suitable for weed control on noncrop areas are available in one or several mixtures.

Soil sterilization is expensive and is practical only where complete vegetation control is desirable and soil erosion is not an important factor. Such areas are around signposts, bridge abutments, trestles along highways and railroads, utility poles and buildings, under guardrails and transformer cages, along pipelines, on tank farms, near structures, and in parking lots and other noncultivated land where accessibility, visibility, fire prevention, and other considerations justify the expense.

Use of Herbicides for Woody Plants in Noncropland

Chemical control of undesirable woody plants along ditchbanks, roadsides, and utility lines; or on flood plains and other noncrop areas, differs from that on pastures and rangelands in the following respects: (1) The noncrop areas of woody plants frequently are in short or narrow strips so that aerial spraying often is not possible. (2) These areas are more often adjacent to or near crops or ornamentals that are sensitive to phenoxy-type herbicides and so much greater care must be used in spraying. (3) Dormant basal spray, frill, or stump treatments frequently must be substituted for foliage sprays along irrigation canals, reservoirs, lakes, and ponds to avoid contamination of water with herbicides not registered for use in water. (4) Noncrop areas generally are closer to adequate supplies of water so that use of high-volume drenching sprays is more economical and feasible than on rangelands. (5) Rapid elimination of undesirable woody plants in noncrop areas frequently is more critical and economically feasible than it is in rangeland. Consequently, higher rates of herbicides and more expensive application methods, such as drenching foliage sprays, aerial spraying with a helicopter, basal sprays, and cut-surface treatments, are commonly used on noncrop areas.

Special Precautions in Use of Herbicides in Noncropland

Even when food and feed crops or desirable ornamental plants are absent from noncrop areas, all general precautions for safe use of herbicides described in the section on basic principles and methods of weed control should be followed. Do not allow livestock to graze ditchbanks, rights-of-way, or similar noncrop areas sprayed with herbicides not registered for use on pastures. Do not feed hay harvested from such areas treated with herbicides not registered for forage crop use. When treating fence rows, use only those herbicides registered for use on the most sensitive area on either side of the fence.

Avoid contamination of irrigation water in canals, ponds, or reservoirs by herbicides not registered for use in aquatic areas and on irrigated crops. Apply such herbicides on banks of irrigation and drainage canals, only when there is no water in the canals.

Use only amine or low-volatile esters of 2,4-D, silvex, or 2,4,5-T for spray applications on noncrop areas that are near sensitive crops or other desirable plants, and prevent spray drift onto the desirable plants. Use low spraying pressures and high volumes of water or oil to reduce the danger of spray drift. Also use invert emulsions of ester formulations and of particulating

Use Pesticides Safely-Follow the Label

or other thickening agents with water-soluble herbicides to avoid spray drift to desirable plants.

Specific Weed Problems, Treatments, and Remarks

Examples of various herbicide treatments that have been used successfully in noncropland are given below. These examples show the scope of herbicide usage in noncropland. They are also guides for the use of herbicides under local conditions. However, rate ranges rather than specific rates are given. Times of application are given in general terms because local climate, soil composition, slope of land, proximity to canals or ponds or desirable plants, and methods required for their safe use. Spot treatments for control of perennial weeds should be used where possible, especially where there is a possibility of contaminating water or injuring nearby desirable plants. Specific details for the safe and effective local use of herbicides can be obtained from weed specialists in the State agricultural experiment stations.

Broadleaf herbaceous weeds (selective control in desirable grasses)

PROBLEM: Annuals, seedling or shallow-rooted perennials.

TREATMENT:

No. 1: Dicamba at 0.5 to 1 lb./A on early weed growth in spring. Remarks: Kills only top growth of many established perennials.

No. 2: 2,4-D at 1 to 2 lb./A on early growth to first bloom. Repeat as necessary to maintain control during growing season.

No. 3: 2,4,5-T at 1 to 2 lb./A on early growth to full bloom on weeds difficult to control with 2,4-D, such as nightshade.

No. 4: Silvex at 1 to 2 lb./A on early growth to full bloom on weeds difficult to kill with 2,4-D, such as black medic, chickweed, clover.

PROBLEM: Deep-rooted and other hard-to-kill biennials and perennials.

TREATMENT:

No. 1: Dicamba at 0.25 to 2; 4 to 8 lb./A when weeds are in active growth stage. The highest rates may injure grass temporarily, and are effective as soil treatments made before periods of precipitation.

No. 2: Picloram at 0.5 lb./A on very active vegetative growth to early bloom in spring or summer during vigorous rosette growth, or as soil application in the fall. Precautions: Use special care to avoid spray drift on desirable plants or contamination of irrigation water; apply only as thickened spray; picloram persists for several years in some soils.

No. 3: Picloram plus 2,4-D mixtures (follow instructions on label).

PRECAUTIONS: Same as for picloram used alone.

No. 4: 2,3,6-TBA at 10 to 20 lb./A sprayed on succulent foliage, preferably during period of adequate rainfall. PRECAUTIONS: Some desirable grasses injured by high rates.

No. 5: 2,4-D at 2 to 4 lb./A sprayed on vegetative growth to early bloom in spring or summer, or on vigorous rosette growth in fall. Repeat as necessary to eliminate or reduce stand.

No. 6: 2,4,5-T at 2 to 4 lb./A. Use same as 2,4-D but on weeds resistant to 2,4-D, such as perennial horsenettle. PRECAUTIONS: Do not use where drift or runoff may contaminate water; or apply sprays in close proximity to residential sites.

Weedy grasses and sedges where control of broadleaf weeds is not necessary

PROBLEM: Annuals and seedling perennials.

TREATMENT:

No. 1: Aromatic oil at 40 to 80 gal./A sprayed on young growth. Repeat as necessary to maintain control.

No. 2: Dalapon at 5 to 10 lb./A sprayed on new growth 4 to 8 in. tall. Repeat as necessary to maintain control.

No. 3: Dinoseb fortified fuel oil at 40 to 80 gal./A sprayed on new growth. Use 2 to 3 pints dinoseb/100 gal. fuel oil. PRECAUTIONS: Do not contaminate water to be used for livestock watering or domestic purposes.

PROBLEM: Established perennials (bermudagrass, johnsongrass, phragmites, paragrass, quackgrass, reed canarygrass, and sedges).

TREATMENT:

No. 1: Amitrole at 4 to 10 lb./A sprayed on new growth before heading. Repeat 2 to 3 times each season to eliminate or reduce stand. Lower rates will suppress growth. PRECAUTIONS: Do not contaminate water to be used for livestock watering or domestic purposes.

No. 2: Amitrole-T at 4 to 8 lb./A used the same as amitrole.

No. 3: Aromatic oil at 120 to 160 gal./A sprayed on new growth before heading. Repeat every 3 to 4 weeks during growing season to eliminate or reduce stand.

No. 4: Dalapon at 10 to 15 lb./A sprayed on new growth. Repeat as necessary to suppress growth.

- No. 5: Dalapon at 20 to 30 lb./A sprayed on early growth to early heading. Repeat every 6 to 8 weeks or as necessary to eliminate or reduce stand.
- No. 6: Dinoseb fortified fuel oil at 120 to 160 gal./A sprayed on new growth. Use 2 to 3 pints dinoseb/100 gal. fuel oil. Repeat every 3 to 4 weeks during growing season.
- No. 7: DSMA at 2.5 to 7 lb./100 gal. of water. Treat when weeds are actively growing. Remarks: Spray plants until thoroughly wet. Add 2 to 3 pints of surfactant/100 gal. water.
- No. 8: MSMA or cacodylic acid at 2 to 5 lb./A on actively growing weeds. Remarks: Add 1 to 2 qt. of surfactant and spray plants until thoroughly wet.
- No. 9: TCA (sodium) at 20 to 40 lb./A sprayed on dead top growth of reed canarygrass after freezes in late fall. Follow with amitrole-T at 4 lb./A in midsummer to kill canarygrass seedlings. Remarks: Encourages establishment of redtop, bluegrass, and other desirable low-growing grasses.
- No. 10: TCA (sodium) at 50 to 200 lb./A sprayed on aftermath growth in fall or as soil treatment. Remarks: More effective when adequate precipitation follows. At lower rates, desirable grasses may be seeded next season.

Mixed herbaceous and grass weeds

PROBLEM: Annuals, biennials, shallow-rooted perennials, and seedling perennials (lower rates); established deep-rooted and hard-to-kill perennials (higher rates).

TREATMENT:

- No. 1: Amitrole-T at 3 to 5; 6 to 12 lb./A. Spray on foliage at early growth to first bloom. Repeat as necessary to maintain control or eliminate stand. PRECAUTIONS: Do not contaminate water to be used for irrigation, domestic use, or livestock watering.
- No. 2: Amitrole plus simazine mixture (follow directions on label). Remarks: Give longer lasting control than amitrole alone. PRECAUTIONS: Do not contaminate water to be used for irrigation, domestic purposes, or livestock watering.
- No. 3: AMS at 50 to 100 lb./100 gal. of water. Spray on active growth. Mix 0.5 to 2 lb./gal. water and spray to wet foliage. Remarks: Effective on woody and herbaceous plants. One formulation registered for use adjacent to aquatic areas including domestic water supplies.
- No. 4: Aromatic oil at 40 to 80; 120 to 160 gal./A. Spray on new growth. Repeat as necessary or every 3 to 4 weeks to eliminate or reduce stand.

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- No. 5: Borate (sodium) at 30 to 120 lb./1,000 sq. ft.; 1,300 to 5,200 lb./A. Apply to active or dormant growth. Precipitation required after application.
- No. 6: Borate mixtures with sodium chlorate or other chemicals or both (follow instructions on label). Spray on active growth or make soil applications before period of adequate precipitation Remarks: Commonly used where soil sterilization (bare soil) is desired.
- No. 7: Bromacil at 3 to 6; 10 to 25 lb./A. Before or during early growth of weeds. Remarks: Apply higher rates before period of greatest precipitation. Adequate precipitation required following application.
- No. 8: Chlorate (sodium) at 300 to 600; 700 to 1,300 lb./A. Spray foliage or make soil applications before period of adequate precipitation.
PRECAUTIONS: Observe all precautions to avoid fire hazard.
- No. 9: Chlorate mixtures with borates or other chemicals (follow directions on label). Use same as chlorate alone. Remarks: Fire hazard usually less than chlorate alone but caution is necessary.
- No. 10: Dalapon at 5 to 10 or 15 to 30 lb./A plus 2,4-D or silvex at 1 to 2 or 2 to 4 lb./A. Spray early growth to early bloom. Use silvex where broadleaf weeds or brush resistant to 2,4-D are present.
- No. 11: Diuron or monuron at 5 to 20; 20 to 60 lb./A before period of adequate precipitation. Remarks: Diuron gives longer soil sterility; monuron more effective on deep-rooted weeds.
- No. 12: Dinoseb fortified fuel oil at 40 to 80; 120 to 160 gal./A on young growth to first heading. Repeat as necessary to maintain control or every 3 to 4 weeks to eliminate or reduce stand; use 2 to 3 pints dinoseb/100 gal. fuel oil.
- No. 13: Erbon at 120 to 160 lb./A when weeds are young and succulent or during period of adequate precipitation. Remarks: Make soil applications in late fall or winter in regions of wet winters and dry summers.
- No. 14: Ethylene glycol bis(trichloroacetate) at 10 to 20 lb./A. Spray when weeds are about 12 in. tall. Remarks: Apply in fuel oil in sufficient volume to completely cover foliage.
- No. 15: Monuron-TCA at 20 to 40; 40 to 66 lb./A when weeds are young and succulent or during period of adequate precipitation. Remarks: Make soil applications in late fall or winter in regions of wet winters and dry summers.
- No. 16: Oil at 40 to 50 gal./A aromatic or fortified fuel, plus 2,4-D ester at 2 to 3 lb./A on young growth up to first heading. Apply same as for aromatic or fortified fuel oil. Remarks: More economical and often more effective than oil alone.

No. 17: Paraquat (cation) at 0.5 to 2 lb./A. Spray young growth. Repeat as necessary to maintain control. Remarks: Kills top growth only of perennials.

No. 18: Prometone at 10 to 15; 20 to 60 lb./A. Before weed emergence or during early growth. Mix in water or oil. Remarks: Oil mixture kills top growth quicker. Precipitation required for effective preemergence treatment.

No. 19: Simazine or atrazine at 5 to 20; 20 to 40 lb./A. Spray before or during early growth to first heading of weeds. Remarks: Simazine requires more precipitation for effective root kill; remains effective in soil longer.

Undesirable woody plants

PROBLEM: Alder, baccharis, boxelder, cottonwood, poplar, sycamore, willow, and other species susceptible to 2,4-D.

TREATMENT: 2,4-D at 2 to 4 lb./A at full leaf in spring or early summer. Remarks: Apply in 100 to 300 gal. water/A with ground equipment, or in 5 to 10 gal. water, oil-water, or invert emulsion per acre by airplane or helicopter.

PROBLEM: Species resistant to 2,4-D or in areas near crops susceptible to 2,4-D.

TREATMENT:

No. 1: AMS at 7 to 10 lb. in 2 gal. water. Remarks: Spray over freshly cut stump or in frills or notches cut around base of tree. Cut notches every 6 in. around circumference of tree; crystals may be sprinkled liberally over cut stumps or in frills or notches.

No. 2: AMS at 60 lb./100 gal. water at full leaf in spring or summer. Remarks: Thoroughly wet foliage; with airblast mist-spray equipment use 100 to 400 lb./100 gal. water and apply at lower volume; to apply in oil-water emulsion follow directions on label. PRECAUTIONS: Use mist spray only in areas far removed from susceptible crops.

No. 3: Fenuron (where precipitation exceeds 15 in. annually) at 12 to 25 lb./A in spring from bud growth to full leaf and just before or during periods of adequate precipitation. Remarks: Apply broadcast or in grid pattern with 1 to 2 teaspoonfuls 3 feet apart; apply same rate around base of individual trees or clumps of brush for spot treatments. Increase rate 50 percent for cherry, dogwood, elderberry, osageorange, persimmon, and sassafras.

No. 4: Fenuron-TCA at 12 to 25 lb./A. Spray at full leaf stage or broadcast granular or pelleted formulations before or during periods of precipitation in spring. Remarks: Available in liquid, granular, and pelleted formulations.

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- No. 5: Picloram at 6 to 8.5 lb./A. Broadcast granules just before or during periods of precipitation. Remarks: Highest rate is necessary for ash, blackgum, and oak; for spot treatments under individual trees or clumps of brush broadcast 1 to 2 tablespoonfuls/30 sq. ft. of soil surface. Picloram persists for 3 years in some soils. PRECAUTIONS: Do not use near ornamentals or other desirable plants, and avoid treating areas where runoff may reach cropland or irrigation water.
- No. 6: Picloram plus 2,4-D mixture (follow instructions on label). Spray at full leaf during vigorous growth. Remarks: Spray solution may also be applied to cut stumps or in frills; apply only in thickened spray; picloram persists in some soils for 3 years. PRECAUTIONS: Use extreme care to avoid drift of spray to nearby desirable plants, and do not contaminate water to be used for irrigation.
- No. 7: Silvex at 2 to 4 lb./A. Spray at full leaf during active growth; spring treatments are best for some species, such as saltcedar. Remarks: Silvex is especially effective on maple, mulberry, palmetto, redbud, saltcedar, trumpetvine.
- No. 8: 2,3,6-TBA at 10 to 20 lb./A. Spray foliage and soil when conditions are suitable for active growth. Remarks: Especially effective on woody vines.
- No. 9: 2,4,5-T at 2 to 4 lb./A. Spray at full leaf during active growth; spring treatments best for some species, such as saltcedar. Remarks: Especially effective on brambles, mesquite, oak, osageorange. PRECAUTIONS: Do not use where contamination of any type of water may occur. Do not use sprays in close proximity to susceptible crops or residential areas.

Supplemental Information

1. Rates are in terms of acid equivalent or active ingredient of herbicide which may or may not correspond to the same units of concentration of the formulation.
2. Some herbicides registered for use on noncropland may not be included in this guide.
3. During the use of herbicides recommended for control of perennial grasses or sedges, the weakened stands are frequently invaded by broadleaved weeds. One to 2 lb./A of amine or low-volatile ester derivatives of 2,4-D added to the treatment for grass control will usually eliminate the broadleaved weeds.

CONTROL OF AQUATIC WEEDS

Construction Aids

Impounded water--Deepening the edges of ponds, lakes, and reservoirs to 2 or more feet and filling in marshy spots prevent or reduce growths of emerged weeds, such as cattail, bulrush, and waterprimrose. Also, the border of submersed weeds may be narrowed and consequently more easily managed. Removal of stumps, logs, and other obstructions from ponds, lake margins, and access channels facilitates the use of underwater mowers and weed harvesters.

Irrigation channels--A uniform gradient and absence of high or low spots in the bottom of an irrigation canal permit thorough draining of water and effective and economical control of submersed waterweeds after 3 or 4 days of drying. Deep canals with steep gradients and rapid waterflow provide less favorable conditions for growth of rooted submersed weeds.

Lining irrigation and drainage canals with concrete or asphalt usually prevents or reduces the growth of rooted submersed weeds. However, filamentous algae may grow on concrete linings and structures and greatly reduce waterflow capacity. Also, silt deposits left on the bottoms of lined canals will support obstructive growths of rooted submersed weeds in water as deep as 8 or 10 ft. A few species will grow at depths of 25 or 30 ft.

Careful designing and spacing of checks, weirs, turnouts, bridges, and other structures along canals minimize interference with the operation of equipment for mechanical or chemical control of aquatic weeds. Shaping ditchbanks to provide uniform crowns and slopes, and maintaining roadways on one or both banks, are essential for efficient chaining, dragging, mowing, or spraying operations to control aquatic weeds.

See list of metric equivalents for weight, volume, area, and linear dimensions in the appendix.

Management Practices For Weed Control

As supplements to proper design and construction of canals, ponds, lakes, and reservoirs, a number of management practices can be utilized to control aquatic weeds or prevent them from becoming a problem. These practices include draining, flooding, fertilization, and livestock grazing.

Draining

For control of submersed weeds in irrigation canals with uniform flow gradients, drain completely and allow the canals to dry for 3 or 4 days. Repeat as necessary during periods when water is not critically needed for irrigating crops.

To control cattails and certain other emerged weeds in ponds, marshes, and wet lands, drain water off, plow the ground, and let it dry for a few weeks.

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Flooding

Maintain the water level at a depth of 3 ft. or more for several months to control cattails and certain other emerged weeds.

Fertilization

In the Southern States, frequent application of NPK (nitrogen, phosphorus, potassium) mineral fertilizers in ratios of 8-8-2, 10-10-5, or higher, stimulates a dense growth or "bloom" of microscopic algae which shades the pond bottom and prevents or reduces the growth of rooted submersed weeds. To control rooted submersed weeds and waterlilies in ponds with stable water levels, apply 100 to 200 lb./A of NPK mineral fertilizer (analysis 8-8-2) beginning in late winter or early spring, and at 10-day intervals thereafter, until a white disk placed 12 to 14 in. below the water surface is invisible. Subsequently apply fertilizer as necessary to maintain the density of the algal "bloom". Fertilization does not control submersed weeds where the outflow or change of water in a month exceeds the water storage capacity of the canal or pond. Nor will fertilization control weeds in cooler waters of the Central and Northern States.

Livestock Grazing

Intensive grazing by livestock, where practicable and safe, provides effective and economical control of most kinds of emerged and marsh species of weeds, including aquatic grasses, sedges, rushes, reeds, cattails, alligatorweed, watercress, and willows. Avoid grazing where it causes serious erosion of steep banks or loose soil. Ducks often effectively control duckweed in small ponds.

Hand and Mechanical Control

Although the traditional hand and mechanical methods of controlling aquatic weeds have recently been replaced to a large extent by herbicides, the hand and mechanical methods are still advantageous in many situations.

Control of submersed weeds by mechanical methods often is less costly than chemical methods in canals with flows of water greater than 70 cfs. However, in canals that supply water for sprinkler irrigation, mechanical methods are undesirable because fragments of dislodged weeds that remain in the water often clog sprinkler heads, valves, screens, and other irrigation equipment.

Hand Pulling

Young plants of cattail, buttonbush, willow, and certain other emerged or marsh species can be eliminated by hand pulling. However, frequent inspection of the channel, pond, or marsh and pulling when plants are young and few in number are necessary for effective and economical control.

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Underwater Mowing and Mechanical Harvesting

Self-propelled and boat-mounted movers and harvesters that cut off submersed or emersed weeds below the water surface at depths of 6 in. to 6 ft. are available. They are restricted to operation in open water areas unobstructed by stumps, trees, and other physical limitations such as access and topography of the shoreline.

To eliminate cattails, cut the stems off below the water surface during the early heading stage and again 1 to 2 months later when all regrowth is emersed. A third cutting is necessary when regrowth occurs a second time.

Small patches of weeds such as waterlilies and watershield can be eliminated by cutting the leaves off below the water surface at frequent intervals. Five or six cuttings a year may be necessary.

For temporary control of submersed waterweeds in large canals, rivers, around boat docks, and in fishing and swimming areas of ponds and lakes, mow off as deeply as possible and remove dislodged weeds. In canals the dislodged weeds should be trapped downstream and removed by dragline or other device to prevent them from lodging against structures, clogging the canal, and causing overflows, canal breaks, or washed-out structures. In ponds and lakes weed debris accumulating in shallow water along the shoreline because of wave action can be removed by draglining, cabling, conveying, harvester type devices, or other mechanical means. Disposal of mowed and harvested weeds is both difficult and costly.

Chaining and Dragging

For removal of submersed waterweeds from irrigation or drainage canals, pull a heavy chain, drag, or disk upstream along the bottom of the canal with a tractor on each bank. Several trips are usually necessary to dislodge all weed growth. Trap the floating masses of weeds at strategic places downstream and remove mechanically or by hand.

Biological Control

Several species of herbivorous fish have been recommended for control of certain species of submersed weeds. Other organisms under study include certain insects to control alligatorweed and waterhyacinth; large fresh-water snails to control algae, submersed weeds, waterfern, and possibly waterhyacinth; and several low-growing submersed species, such as waterplantain, spikerush and dwarf sagittaria, as effective competitors with ranker growing, more troublesome pondweeds in large irrigation canals.

In some Southern states, species of branched filamentous algae are controlled in ponds by stocking with fifty 5 in. or larger Israeli carp per acre. Under these temperature conditions the Israeli carp usually will not muddy the water.

The Agasicles beetle has been used successfully for control of alligatorweed in the Southern states, such as Florida, Louisiana, and Texas. Studies on other biological control agents have not progressed to the extent that they are acceptable to State and Federal agencies, or that recommendations for their use are possible.

Chemical Control

Copper sulfate was first used to control algae in 1904, and sodium arsenite was used to control waterhyacinth in 1902 and submersed weeds in 1927. However, most of the herbicides now registered by the Environmental Protection Agency for use in controlling one or more aquatic weeds were discovered since 1945. Herbicides often give more effective, longer lasting, and less expensive control of aquatic weeds than do mechanical or hand methods.

A few aquatic herbicides are poisonous to humans and other warmblooded animals and must be handled and used with caution and according to special procedures. Some herbicides are toxic to fish, but most do not injure fish at concentrations required to kill weeds. Most aquatic herbicides do not injure crops irrigated with water at concentrations required for weed control, but a few may injure crops at low concentrations if they are used carelessly.

Only limited information is available on the persistence and fate of herbicides in water, aquatic soil, fish, and aquatic plants. Therefore, in addition to following all general precautions for the safe use of herbicides described in the section on basic principles and methods of weed control, and the special precautions in the following subsection, the user of an aquatic herbicide must follow carefully all instructions and restrictions on the label regarding aquatic situations in which the herbicide should not be used. He must know how much time should elapse after herbicide treatment before treated water may be used for drinking, fishing, swimming, and irrigating crops.

Specific Weed Problems

Examples of herbicide treatments that have been used successfully and safely for control of aquatic weeds are given below. These examples show the scope of herbicide usage for aquatic weed control. They are also guides for the use of herbicides under local conditions.

However, rate ranges rather than specific rates are listed, and times of application are given in general terms because local climate, altitude, water temperature, water uses, and site conditions affect the performance and persistence of herbicides and procedures required for effective and safe use. At present, no herbicide is registered for use in controlling aquatic weeds in streams, rivers, estuaries, or marine sites. Consequently, the herbicide uses listed are restricted to irrigation canals and drains, ponds, lakes, and reservoirs. Details for the safe and effective use of aquatic herbicides in specific areas can be obtained from aquatic weed specialists of the State and Federal agencies familiar with the particular local situation.

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Floating weeds (unattached, tops above water)

PROBLEM: Alligatorweed (floating mats), duckweed, waterfern, waterhyacinth, waterlettuce.

TREATMENT: (general control): 2,4-D amine salts or low volatile esters at 2 to 4 lb. in 100 gal. of water per acre. Spray on actively growing weeds. Remarks: Include 10 gal. of fuel oil and 1 pint emulsifier for waxy or hairy hard-to-wet foliage or in rainy season; repeat every 4 to 6 weeks to maintain control. Treatment seldom gives complete elimination of stand of weeds. PRECAUTIONS: Do not use near crops sensitive to 2,4-D. Use 2,4-D esters and formulations least toxic to fish.

PROBLEM: Duckweed.

TREATMENT: Diquat (cation) at 0.5-1 ppm. Inject into water or spray on foliage when weeds are actively growing. Remarks: Much less effective when used in muddy water.

PROBLEM: Waterhyacinth and waterlettuce alone or in mixed stands.

TREATMENT: Diquat (cation) at 1 to 1.5 lb./A. Apply on actively growing weeds as surface spray in 150 to 200 gal. water or as aerial spray in 7.5 gal. water.

PROBLEM: Alligatorweed (eradication of floating mats).

TREATMENT: Silvex esters at 8 lb./A. Apply as spray in 150 to 200 gal. water/A at first bloom; retreat when regrowth is 2 to 4 in. above water. Remarks: Two to 4 applications required for eradication. PRECAUTIONS: Do not use in water to be used for irrigation, domestic purposes, or livestock watering. Use esters and formulations least toxic to fish.

Emerald and marginal weeds (rooted under water, tops above water, or growing on saturated soil)

PROBLEM: Broadleaf species (general control).

TREATMENT: Silvex or 2,4-D at 2 to 4 lb./A. Apply as spray in 200 gal. water/A to uniformly wet foliage when weeds are actively growing. Remarks: Reduce volume but not herbicide application rate when foliage is wet; repeat as necessary to maintain control or eliminate stand. PRECAUTIONS: Do not contaminate water to be used for irrigation, domestic purposes, or livestock watering. Use amines or low-volatile esters and formulations least toxic to fish.

PROBLEM: Arrowhead, lotus, pickerelweed, smartweed, spatterdock, spikerush, waterprimrose, white waterlily, and other plants with waxy leaves.

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TREATMENT: 2,4-D low volatile ester at 1 to 4 lb./A. Apply in oil or in oil-water emulsion (1:10 or 1:20) or in invert emulsion to give uniform coverage. Spray when plants are actively growing. PRECAUTIONS: Do not contaminate water to be used for irrigation, domestic purposes, or livestock watering. Use esters and formulations least toxic to fish.

PROBLEM: Rooted, emerged alligatorweed.

TREATMENT: Silvex ester at 8 lb./A. Apply as spray in 150 to 200 gal. water/A at first bloom; retreat when regrowth is 4 to 6 in. above water. Remarks: Two to 4 applications required for elimination. PRECAUTIONS: Do not contaminate waters to be used for irrigation, domestic purposes, or livestock. Use esters and formulations least toxic to fish.

PROBLEM: Perennial grasses and sedges, common reed, cutgrass, johnsongrass, knotgrass, paragrass, quackgrass, ripgut sedge.

TREATMENT: Dalapon at 20 to 30 lb./A. Apply in 100 to 400 gal. of water/A as a ground spray or in 5 to 15 gal. water/A as an aerial spray when grasses are 6 to 18 in. tall and before heading. Add 3 to 4 pints of wetting agent per 100 gal. of water. Remarks: Repeated light applications at 5 to 10 lb./A are more effective on some species, such as paragrass. PRECAUTIONS: Do not contaminate water used for irrigation, domestic purposes, or livestock.

PROBLEM: Waterlilies and spatterdock.

TREATMENT: Dichlobenil at 5 to 10 lb./A. Broadcast granules (containing 4 percent dichlobenil) uniformly over the water surface when the first leaves appear in early spring. Use in spot or partial-area treatments each year. Remarks: Higher rates often give 2 or more years' control. PRECAUTIONS: Do not use treated water for any purpose, or fish from treated water, until 90 days after treatment.

PROBLEM: Bulrushes and cattails.

TREATMENT:

No. 1: Dalapon at 15 to 30 lb./A. Apply as spray with 3 to 4 pints of wetting agent, or 5 to 10 gal. of diesel oil plus 1 pint emulsifier, per 100 gal. spray. Remarks: Apply at fully headed or postheading stage in late summer or early autumn in sufficient volume of spray to give uniform coverage by ground or aerial equipment; apply at earlier growth stage for control during current season and repeat as necessary to eradicate regrowth. PRECAUTIONS: Do not contaminate water used for irrigation, domestic purposes, or livestock.

No. 2: 2,4-D low-volatile esters at 4 to 6 lb./A. Apply in a 1:20 oil-water emulsion at 150 to 300 gal. per acre. Remarks: Make initial application at first heading and repeat on regrowth before heading; 3 or 4 applications usually necessary for elimination. PRECAUTIONS: Do not contaminate water used for irrigation, domestic purposes, or livestock. Use esters and formulations least toxic to fish.

Submersed weeds (tops mostly under water, usually rooted or anchored)

PROBLEM: Algae, blue-green, in lakes, ponds, or reservoirs. Consult weed specialists in State agricultural experiment stations or extension service or fish and wildlife specialists for regulations and herbicide use permit if required.

TREATMENT:

No. 1: Copper sulfate (pentahydrate) at 0.1-0.5 ppm. Apply as crystals or powder at early stage of growth by any method to give rapid and uniform dispersion. Remarks: Repeat as necessary to maintain control. May be used in potable water up to 4 ppm. PRECAUTIONS: Concentrations above 0.15 ppm may injure trout especially in soft water and in the presence of zinc.

No. 2: Dichlone at 0.02-0.05 ppm. Remarks: Same as copper sulfate except that it should not be used in potable water. May injure some species of fish especially in water of high pH and during the spawning season.

PROBLEM: Algae, filamentous, in lakes, ponds, reservoirs.

TREATMENT:

No. 1: Copper sulfate (pentahydrate) at 0.5-1 ppm in soft water. Apply as crystals or powder at early stage of growth by any method to give rapid uniform dispersion. Remarks: Safe on most fish except trout, may be used in potable water up to 4 ppm.

No. 2: Copper sulfate (pentahydrate) at 1-2 ppm in hard water. Apply same as in Treatment No. 1. Remarks: Injurious to most fish, may be used in potable water up to 4 ppm.

No. 3: Endothall (dimethylamine salts) at 0.05-0.2 ppm. Apply uniformly over the water surface or inject below the water surface. PRECAUTIONS: Do not use water for any purpose until 7 days after treatment. Higher rates are extremely toxic to fish and some invertebrates.

PROBLEM: Algae in irrigation or drainage canals.

TREATMENT: Copper sulfate (pentahydrate) at 0.5-1.0 lb./cfs. Apply as crystals or powder in canal upstream from algae infestation. Repeat as necessary to maintain control, usually every 3 to 5 weeks. PRECAUTIONS: Do not use water for domestic purposes until the copper sulfate concentration is below 4 ppm. May be toxic to

Use Pesticides Safely-Follow the Label

trout in soft water.

PROBLEM: Rooted or anchored weeds in lakes, ponds, reservoirs, such as bladderwort, cabomba, coontail, elodea, naiad, pondweeds, waterchestnut, water crowfoot, watermilfoil, water pennywort, waterprimrose, waterstargrass.

TREATMENT:

- No. 1: Diquat (cation) at 0.25-0.5 ppm or 0.5-1.5 ppm. Apply over surface or inject below surface in spots or strips so as to obtain complete dispersion in water. Apply before weed growth reaches water surface. Remarks: Low concentrations are sufficient for some weeds, such as naiad, in small ponds. Use higher rates for other species or for spot treatments. PRECAUTIONS: Do not use water or fish from treated water for 10 days after treatment.
- No. 2: Endothall (dimethylamine salts) at 0.5-2.5 ppm. Apply during early weed growth. Use lower concentrations in total area treatments and higher concentrations for margins, spot treatments, or cold water. PRECAUTIONS: This rate range toxic to fish and invertebrates. Use only for spot treatments or where some fish kill is not objectionable. Do not use water until 25 days after treatment.
- No. 3: Endothall (disodium salt) at 1-4 ppm. Apply at early stage of weed growth. Use lower concentrations in total area treatments and higher concentrations for margins, partial treatments, or cold water; increase the concentration to 5 ppm for spot treatments. Remarks: Follow label directions on use of treated water and fish.
- No. 4: Fenac at 15 to 20 lb./A. Apply to temporarily exposed lake or pond bottoms and shorelines when soil is not frozen. Remarks: Keep water down at least 3 weeks. PRECAUTIONS: Follow label directions on use of treated water.
- No. 5: Potassium salt of silvex (granule or liquid form) at 1.5-2 ppm or 5 lb./acre-foot of water. Apply granules uniformly over the surface of water or inject the liquid below surface at early stage of weed growth. Remarks: Not effective in spot treatments. Will not control certain pondweeds, elodea, or wild celery. PRECAUTIONS: May be toxic to some species of fish. Do not use in water to be used for irrigation, domestic purposes, or livestock watering.
- No. 6: 2,4-D esters (granule or pellet form) at 20 to 40 lb./A. Apply uniformly over water surface by boat or helicopter at early stage of weed growth. Remarks: Use heavy rates for more resistant species in highly acid or alkaline water. Will not control some pondweeds, elodea, or wild celery. PRECAUTIONS: May be toxic to some fish at these rates. Use esters that are least toxic to fish. Do not use in water to be used for irrigation, potable purposes, or livestock.

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PROBLEM: Chara and other rooted or anchored submersed weeds.

TREATMENT:

No. 1: Dichlobenil at 7 to 10 lb./A. Apply to temporarily exposed lake or pond bottoms and shorelines. PRECAUTIONS: Follow label directions on use of treated water.

No. 2: Dichlobenil at 10 to 15 lb./A. Broadcast granules uniformly over water surface before or as soon as new growth begins in spring. Remarks: Increase rates above 10 lb./A for water deeper than 3 ft. and for spot treatments. PRECAUTIONS: Do not use treated water for any purpose, or fish from treated water, until 90 days after treatment.

PROBLEM: Hydrilla, and wild celery in lakes and ponds; also canals with little or very slow water flow.

TREATMENT:

No. 1: Diquat at 1 ppm plus copper sulfate (pentahydrate) at 4 ppm. Mix in polyethylene or other nonmetallic container. Apply over water surface or inject in strips to provide uniform dispersion in water. Remarks: Mixture is more effective than higher concentrations of either chemical alone. May be toxic to fish and invertebrates in soft water of low pH. PRECAUTIONS: Do not use water, or fish from treated water, until 10 days after treatment.

No. 2: Diquat at 1 ppm plus copper sulfate-triethanolamine mixture at 4 ppm. Apply by spraying over the water surface or by injecting below the surface. Do not use water, or fish from treated water until 10 days after treatment. PRECAUTIONS: May be toxic to fish in soft water.

No. 3: Endothall (dimethylamine salts) at 3 ppm. Spray uniformly over strips 30 to 50 ft. wide along lake margin or in other strips or spots. Spray from shoreline out. PRECAUTIONS: This rate extremely toxic to fish. To avoid fish kill, treat water in strips as directed on label. Do not use treated water for 25 days after treatment.

PROBLEM: Most submersed species except waterplantain in irrigation and drainage canals with flowing water.

TREATMENT:

No. 1: Acrolein at 1 to 2.5 gal./cfs. In small canals of 100 cfs. or less inject above the weed infestation over a period of 1/2 to 4 hours using especially adapted equipment. Remarks: Effective kill of plants 6 to 20 miles downstream, depending on weed density. PRECAUTIONS: Very toxic to fish. Do not use in potable water or permit treated water to flow into a stream or lake where fish might be killed.

No. 2: Acrolein at 0.1 to 0.6 ppm. Inject into large canals of 200 to 2,000 or more cfs. at one location during period of 8 to 48 hours. Remarks: Within this range of treatment rates, use lower concentrations and longer periods of application as the size of canals increases; apply from special cylinders under nitrogen gas pressure. PRECAUTIONS: Very toxic to fish. Do not use in potable water or permit treated water to flow into fishing waters.

No. 3: Aromatic solvents (xylene) at 8 to 10 gal./cfs. [600-740 ppm for 30 minutes or 300-370 ppm for 60 minutes]. Remarks: Add 1 to 1.5 percent nonionic-cationic blend emulsifier to the xylene and inject at a point upstream from the weed infestation during a period of 30 to 60 minutes. Boost the concentration of xylene in the treated water with 4 to 5 gal. per cfs. at intervals of 2 to 4 miles downstream, depending on the weed density and velocity of water flow. Apply before weeds are heavy and matted at the water surface. PRECAUTIONS: Xylene is inflammable and may be a fire hazard if used carelessly. These concentrations are very toxic to fish and invertebrates.

PROBLEM: Most submersed weeds in drainage or irrigation canals with little or no water flow.

TREATMENT:

No. 1: Acrolein at 4 to 7 ppm. Apply below water surface continuously along the length of canal with specially adapted equipment. PRECAUTIONS: Very toxic to fish. Do not use in domestic water.

No. 2: Diquat (cation) at 0.25-1 ppm. Apply on or below water surface continuously along length of canal. Remarks: Allow at least 12 hours of exposure of weeds to treated water. Diquat is ineffective in water containing more than a small amount of suspended sediment. PRECAUTIONS: Do not use water or fish from water for 10 days after treatment.

No. 3: Endothall (dimethylamine salt) at 1.5-4 ppm. Use same as diquat. PRECAUTIONS: Toxic to fish. Follow instructions on label for withholding use of water following treatment.

PROBLEM: Submersed weeds and algae in reservoirs and large canals carrying potable water.

TREATMENT:

No. 1: Continuous feed method, copper sulfate at 0.6 to 1 ppm. Begin application of copper sulfate early in the season at 1 ppm and gradually reduce concentration to 0.6 ppm as water temperatures rise. Remarks: Good control of algae, control of large weeds variable, especially in turbid or hard water. PRECAUTIONS: May be toxic to trout and other fish especially in soft water, low pH, and in the presence of zinc.

No. 2: Repeated slug treatments, copper sulfate at 0.3-2 lb./cfs. Make initial applications early in growing season and repeat as necessary for control. Remarks: Use light rates for soft water and heavier rates for water high in salt content, especially carbonates. Slug treatments are made by applying the entire quantity of copper sulfate in large crystals on concrete canal bottom or apron, or by suspending the copper sulfate in water in burlap bags. PRECAUTIONS: May be toxic to trout and other fish in soft water of low pH and in the presence of zinc.

APPENDIX

Metric System Equivalents

Length

Centimeter	=0.3937	inch
Meter	=3.28	feet
Kilometer	=0.621	statute mile
Kilometer	=0.5396	nautical mile
Inch	=2.540	centimeters (or 1000 mils)
Foot	=30.48	centimeters
Yard	=0.914	meter
Rod (16.5 feet)	=5.029	meters
Statute mile (1,760 yards)	=1.61	kilometers

Area

Hectare	=2.471	acres
Acre (43,560 square feet)	=0.405	hectare

Volume

Liter	=1.05	quarts, U.S.
Quart, liquid, U.S. (32 ounce)	=0.946	liter
Quart, imperial (40 ounce)	=1.136	liters
Gallon, U.S. (4 quarts)	=3.785	liters
Gallon, imperial	=4.546	liters

Weight

Gram	=0.035	Avoirdupois ounces
Kilogram	=2.205	Avoirdupois pounds
Metric ton	=0.984	gross or long ton
Metric ton	=1.102	short or net tons
Avoirdupois pound (16 ounces)	=0.4536	kilogram
Avoirdupois ounce	=28.35	grams
Ounce (British Fluid)	=28.41	ml
Ounce (U.S. Fluid)	=29.57	ml
Gross or long ton (2240 pounds)	=1.016	metric tons
Short or net ton (2000 pounds)	=0.907	metric ton

Other conversions

Square inch	=6.45	square centimeters
Pound per square inch	=70.31	grams per square centimeter
30 pounds per square inch	=2.11	kilograms per square centimeter
Pound per acre	=1.12	kilograms per hectare
Gallon per acre	=9.35	liters per hectare
Pound per gallon	=0.12	kilograms per liter

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Weeds Controlled By Individual Herbicides

<u>Herbicide</u>	<u>Weeds Controlled</u>
acrolein	submerged and floating weeds and algae in irrigation ditches, canals, drains, and ponds.
alachlor	barnyardgrass, carpetweed, crabgrass, Florida pusley, giant foxtail, green foxtail, goosegrass, lambsquarters, pigweed, purslane, ragweed, yellow nutsedge.
ametryne	<u>Amaranthus</u> spp., dallisgrass, fireweed, Flora's paintbrush, foxtail, Japanese tea, junglerice, kukaipuaa and other crabgrass species, <u>Panicum</u> spp., purslane, rattle pod, richardia, spanish-needles, sowthistle, wild pea bean, and wiregrass or goosegrass.
amitrole	annual bluegrass, barnyardgrass, Bermudagrass, Canada thistle, cattails, cheatgrass, chrysanthemum, dock, fanweed, foxtail, honeysuckle, horsenettle, horsetail rush, kochia, kudzu, leafy spurge, milkweed, mustard, nutgrass (sedge), phragmites, poison ivy, poison oak, quackgrass, ripgut grass, ryegrass, sow thistle, sunflower, tarweed, volunteer alfalfa, water hyacinth, whitetop (hoary-cress), and wild barley.
AMS	<u>Annuals</u> : broomweed, chickweed, cocklebur, crabgrass, jimsonweed, lambsquarters, larkspur, prickly lettuce, ragweed, and shepherdspurse. <u>Woody Perennials</u> : poison ivy, poison oak, and poison sumac. <u>Herbaceous Perennials</u> : bitterdock, blueweed, goldenrod, horsetail (<i>Equisetum</i>), leafy spurge, milkweed, and perennial ragweed.
atrazine	barnyardgrass, bluegrass, bull thistle, burdock, Canada thistle, cheatgrass, crabgrass, dog fennel, foxtail, lambsquarters, orchardgrass, ragweed, redtop, smooth brome, sow thistle, and turkey mullein.
barban	ryegrass and wild oats.

HerbicideWeeds Controlled

benefin	annual bluegrass, barnyardgrass (watergrass), carelessweed, carpetweed, chickweed, crabgrass, crowfootgrass, Florida purslane (pusley), foxtails, goosegrass, johnsongrass, junglerice, knotweed, lambsquarters, pigweed, purslane, redmaids, ryegrass, sandbur, and <u>Texas panicum</u> (buffalograss).
bensulide	annual bluegrass, crabgrass, deadnettle, foxtail, goosegrass, junglerice, lambsquarters, pigweed, purslane, shepherdspurse, and watergrass.
boron compounds	kills all vegetation.
bromacil	aster, Bahiagrass, Bermudagrass, bluegrass, bouncing bet, bracken fern, broomsedge, dallisgrass, dandelion, dogbane, dog fennel, goldenrod, horsetail, johnsongrass, nutsedge, plantain, purpletop, quackgrass, redtop, saltgrass, smooth brome, and Vaseygrass.
bromoxynil	blue (purple) mustard, corn gromwell, cow cockle, fanweed, fiddleneck, field pennycress, green smartweed, lambsquarter, London rocket, shepherdspurse, silver leaf nightshade, tartary buckwheat, tarweed, tumble (Jim Hill) mustard, wild buckwheat, and wild mustard.
butylate	barnyardgrass, crabgrass, giant foxtail, goosegrass, green foxtail, johnsongrass (seedling), purple nutgrass, yellow foxtail, and yellow nutgrass.
cacodylic acid	kills all vegetation.
CDAA	annual bluegrass, barnyardgrass, carpetweed, cheat, crabgrass, giant foxtail, green foxtail pigweed, purslane, stinkgrass, watergrass, and yellow foxtail.
CDEC	annual bluegrass, barnyardgrass (watergrass), Bermuda-grass, broadleaf perennials, bullgrass (goosegrass), carelessweed, chickweed, crabgrass, foxtail, grass perennials, henbit or blueweed, johnsongrass, lambsquarters, morningglory (possession vine), nutgrass, pigweed (redroot), pigweed (spiny), purslane, quackgrass, and white horse nettle.
chloramben	chickweed, coffee weed, crabgrass, fall panic grass, giant foxtail, green and yellow foxtail, kochia, lambsquarters, pigweed, ragweed, seedling johnsongrass, smartweed, velvetleaf, and wild mustard.

HerbicideWeeds Controlled

chlorbromuron	broadleaf weeds including white brush.
chloroxuron	annual bluegrass, barnyardgrass, black nightshade, brachiaria, carpetweed, chickweed, cocklebur, crabgrass, Florida pusley, goosegrass, groundsel, jimsonweed, lambsquarters, lovegrass, morningglory, pogweed, pineappleweed, puncturevine, purslane, ragweed, shepherdspurse, sicklepod, smartweed, spurry, velvetleaf, and wild mustard.
chlorpropham	annual bluegrass, barnyardgrass (watergrass), brome grass, carpetweed, chickweed, crabgrass, dodder, false flax, field sorrel, foxtail, knotweed, old witchgrass, purslane, rattail fescue, ryegrass, smartweed, stinkgrass, wild buckwheat, and wild oats.
copper sulfate	controls algae.
cycloate	annual bluegrass, annual ryegrass, volunteer barley, black nightshade, crabgrass, foxtails, hairy nightshade, lambsquarters, nettleleaf goosefoot, purple nutgrass, purslane, redroot pigweed, shepherdspurse, small stinging nettle (burning nettle), watergrass (barnyardgrass), wild oats, and yellow nutgrass.
cyprazine	barnyardgrass, burdock, cocklebur, crabgrass, giant foxtail, green foxtail, jimsonweed, lambsquarters, morningglory, sunflower, velvet leaf, yellow foxtail.
cypromid	many germinating broadleaf weeds and weedgrasses.
DCPA	annual bluegrass, barnyardgrass, browntop, panicum, carpetweed, common chickweed, dodder, Florida pusley, goosegrass, green foxtail, ground cherry, johnsongrass (from seed), lambsquarters, lovegrass, nodding spurge, purslane, redroot pigweed, sesbania, smooth and hairy crabgrass, witchgrass, and yellow foxtail.
diallate	wildoats in certain recommended crops.
dicamba	chickweed, clover, corn cockle, cow herb, dog fennel, downy bromegrass (cheatgrass), and sheep sorrel (red sorrel).

Herbicide

Weeds Controlled

dichlobenil	annual bluegrass, artemisia, bluegrass, Canada thistle, carpetweed, chickweed, crabgrass, cudweed, curly dock, dandelion, evening primrose, fescue, foxtail, groundsel, henbit, horsetail, knotweed, lambsquarters, leafy spurge, orchardgrass, peppergrass, pineapple weed, plantain, purslane, quackgrass, ragweed, redroot pigweed, Russian thistle, shepherdspurse, smartweed, spurge, Texas panicum (hurrahgrass), timothy, wild artichoke, wild aster, wild carrot, wild mustard, yellow rocket, and yellow woodsorrel.
dichlone	controls algae.
dinoseb	chickweed, common ragweed, crabgrass, Florida pusley, foxtails, lambsquarters, purslane, and redroot pigweed.
diphenamid	annual bluegrass, annual sedge, barnyardgrass (watergrass), carpetweed, cheat, common chickweed, corn spurry, crowfootgrass, evening primrose, fall panicum (panic grass), Florida pusley, German moss, giant foxtail, goosegrass, groundsel, johnsongrass, knotweed, lambsquarters, large crabgrass, mouse ear chickweed, peppergrass, pigweed (carelessweed), purslane, red sorrel, ryegrass, sandbur (sandspur), shepherdspurse, smartweed, smooth crabgrass, spiny amaranth (stickerweed), stinkgrass, thyme leaved sandwort, wild oat, witchgrass (ticklegrass), and yellow foxtail.
diquat	bladderwort, coontail, duckweed, elodea, naiad, pennywort, pondweeds, salvinia, waterhyacinth, waterlettuce, and watermilfoil.
diuron	annual morningglory, annual ryegrass, chickweed, crabgrass, foxtail, johnsongrass, lambsquarter, pigweed, purslane, ragweed, Spanish needle, watergrass, and wild mustard.
DSMA	barnyardgrass, cocklebur, dallisgrass, goosegrass, johnsongrass, nutsedge, puncturevine, ragweed, and sandbur.
endothall	annual bluegrass, arrowhead, barnyardgrass, bassweed, bladderwort, blueweed (henbit), bullgrass, bur reed, burr clover, carrotweed, cheatgrass, coontail, fanwort, green foxtail, lotus, milfoil, pondweed, purslane, ragweed, redroot pigweed, setaria, shepherdspurse, smartweed, spike rush, Texas blueweed, volunteer barley, watercress, water hyacinth, water lily, water primrose, water star grass, waterweed, and wild buckwheat.

Herbicide

Weeds Controlled

EPTC	annual bluegrass, annual ryegrass, Bermudagrass, chickweed (common), corn spurry, crabgrass, deadnetter (henbit), foxtails (giant, green, yellow), goosegrass, hairy nightshade (ground cherry), johnsongrass (from seed only), lambsquarters, lovegrass (stinkgrass), nettle-leaved goosefoot, nutgrass (nutsedge), pigweed (redroot, prostrate and tumbling), purslane (pursley), quackgrass, sandbur, volunteer grain (barley, oats, wheat), watergrass (barnyardgrass), and wild oats.
ethylene glycol bis(trichloroacetate)	kills many established weeds on contact.
erbon	Bermudagrass, bindweed, bluegrass, buckhorn plantain, bur ragweed, dandelion, goldenrod, johnsongrass, leafy spurge, mustard, orchardgrass, pigweed, quackgrass, Russian knapweed, saltgrass, wild carrot, and wild primrose.
fenac	American elodea pondweed, American pondweed, coontail, leafy pondweed, milfoil sp., sago pondweed, slender spike rush, southern naiad, water stargrass, and waterthread pondweed.
fenuron	birch, boxelder, cedar, cherry, dogwood, elderberry, elm, ground juniper, gum, hackberry, hawthorn, hazel, hickory, locust, maple, mulberry, oak, pine, poplar, red bud, sumac, sycamore, and sassafras.
fenuron TCA	briars, Canada thistle, hickory, most other annual and perennial weeds on noncropland, oak, sassafras, sumac, trumpet vine and wild cotton.
ferrous sulfete	weeds in cranberry plantings.
fluometuron	barnyardgrass, brachiaria, buttonweed, cocklebur, crabgrass, crowfootgrass, fall panicum, Florida pusley, foxtail, goathead, goosegrass, jimsonweed, lambsquarters, morningglory, pigweed, prickly sida (ironweed or teaqued), purslane, ragweed, ryegrass, sesbania, sicklepod, smartweed, and tumbleweed.
fluorodifen	weedgrasses including barnyardgrass, brachiaria, crabgrass, giant foxtail, goosegrass, green foxtail, yellow foxtail. Broadleaf weed including black nightshade, carpetweed, common ragweed, Florida pusley, jimsonweed, lambsquarters, pigweed, purslane, smartweeds, wild mustard.

Herbicide

Weeds Controlled

linuron	barnyardgrass, buttonweed, crabgrass, foxtail, lambsquarters, pigweed, purslane, ragweed, and smartweed.
MCPA	burdock, cocklebur, dandelion, mustards, pigweed, plantain, purslane, ragweed, shepherdspurse, stinkweed, and thistles.
MCPB	annual morningglory, Canada thistle, lambsquarter, pigweed, smartweed, and sow thistle.
metham	annual bluegrass, Bermudagrass, carelessweed, chickweed, dandelion, henbit, johnsongrass, lambsquarters, nutgrass, pigweed, purslane, watergrass, and wild morningglory.
methyl bromide	as a soil fumigant kills vegetation and weed seeds.
metobromuron	annual bluegrass, annual morningglory, barnyardgrass, black nightshade, carpetweed, cocklebur, common chickweed, corn spurry, crabgrass, fall panicum, goosegrass, green foxtail, henbit, kochia, ladysthumb, lambsquarters, pepperweed, pigweed, pineappleweed, prickly sida, purslane, ragweed, shepherdspurse, sicklepod, smartweed, speedwell, stinkgrass, wild mustard, wild radish, wild rutabaga, witchgrass, and yellow foxtail.
molinate	barnyardgrass in rice.
monuron	annual morningglory, chickweed, crabgrass, foxtail, johnsongrass, lambsquarters, pigweed, purslane, ragweed, Spanish needle, watergrass, and wild mustard.
monuron TCA	Most annual and perennial grasses and broadleaf weeds on noncropland.
MSMA	cocklebur, dallisgrass, goosegrass, johnsongrass, nutgrass, puncturevine, ragweed, sandbur, and watergrass.
naptalam	barnyardgrass, bindweed, carpetweed, chickweed, cocklebur, crabgrass, cupgrass, foxtail, goosegrass, ground cherry, johnsongrass (from seed), lambsquarters, pigweed, ragweed, sandbur, shepherdspurse, sprangletop, stinkgrass, velvetleaf, watergrass, windmillgrass.
naphtha	see oils, aromatic.

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Herbicide

Weeds Controlled

nitralin	<u>Grasses</u> : annual bluegrass, annual ryegrass, Brachiaria, crabgrass, downy brome, foxtails, goosegrass, johnson-grass (from seed), watergrass and wild oats. <u>Broadleaves</u> : bull mallow, cress, curly dock, dead nettle, fiddleneck, groundsel, knotweed, lambsquarters, pigweed, plantains, prickley lettuce, purslane, and shepherdspurse.
nitrofen	annual bluegrass, crabgrass, goosefoot, groundsel, lambsquarter, malva, nettle, nightshade, pigweed, purslane, shepherdspurse, and spergularia.
nitrogen solutions	most young growing annual weeds.
norea	annual chickweed, barnyardgrass, brachiaria, Colorado grass (harrahgrass), cocklebur, crabgrass, Florida pusley, foxtails, goosegrass, henbit, lambsquarters, morningglory, panicum (summer and fall), pigweed, and purslane.
oils, aromatic	young growing weeds and submersed aquatic weeds.
paraquat	Bermudagrass, bluegrass, burclover, cheatgrass, chickweed, crabgrass, filaree, groundsel, johnsongrass, morningglory, nettle, pigweed, plantain, puncturevine, purslane, red clover, shepherdspurse, thistle, wild mustard, wild oats, and wild radish.
PCP	crabgrass, green and yellow foxtails, lambsquarters, and pigweed.
pebulate	crabgrass, dead nettle (henbit), foxtails, hairy nightshade (ground cherry), lambsquarters, millet setaria, nettle-leaved goosefoot, pigeon grass, prostrate pigweed, purslane, redroot pigweed, watergrass (barnyard), wild oats, and yellow nutgrass.
phenmedipham	babiagrass, barley (volunteer), bentgrass, bluegrass (annual and perennial), brome-grasses (annual), canary-grass, cheatgrass, fescues, goosegrass, oats (wild), quackgrass, ryegrass (annual and perennial), chickweed, dock (curly), dodder, henbit, knotweed, lambsquarters, mustards, nettle (burning), nightshade (prickly), purslane, sorrel (sheep), shepherdspurse.

HerbicideWeeds Controlled

propachlor	barnyardgrass (watergrass), carpetweed, crabgrass, Florida pusley, giant foxtail (wild millet) goosegrass, green foxtail, lambsquarters, pigweed, purslane, ragweed, and yellow foxtail.
propanil	alligatorweed, barnyardgrass, brachiaria, crabgrass, croton, curly indigo, foxtail, goosegrass, gulf cockspur, hoorahgrass, jointed sedge, junglerice, Mexican weed, nutsedge, paragrass, pigweed, redweed (teaweed), sour dock, spearhead, spike rushes, tall indigo or coffee bean, Texas millet, and water plantain.
propazine	annual morningglory, carpetweed, foxtail, lambsquarters, pigweed, ragweed, smartweed, and velvetleaf.
propham	annual bluegrass, annual ryegrass, bromegrass, canary grass, chickweed, downy brome (cheatgrass), pigeongrass, rabbitfoot grass, rattail fescue, small nettle, velvetgrass, volunteer grains, and wild oats.
pyrazon	burning nettle, chickweed, dock, fanweed, field pennycress, henbit, ironweed, knotweed, lambsquarters, mustard, nettle leaf goosefoot, nightshade, pigweed, purslane, ragweed, shepherdspurse, smartweed, sorrel, spurge, and wild radish.
siduron	barnyardgrass, bentgrass, certain strains, bluegrass, crabgrass, smooth and hairy, fescue, foxtail, orchardgrass, perennial ryegrass, redtop, smooth brome, and zoysia.
silvex	alligatorweed, blackjace oak, broomweed, cocklebur, croton weed, curly indigo, ground ivy, lambsquarters, maples, mesquite, Mexican weed, northern oaks, poison ivy, pokeberry, post oak, ragweed, salt cedar, sand shinnery oak, sunflower, wild blackberry, and yucca.
simazine	annual bluegrass, annual ryegrass, common chickweed, crabgrass, lambsquarters, and pigweed.
sodium chlorate	sterilizes soil.
stoddard solvent	young growing annual weeds.
table salt	broadleaf weeds and weedgrasses.
TCA	Bermudagrass, crabgrass, foxtail, Japanese chess, johnsongrass, paragrass, phragmites, and quackgrass.

HerbicideWeeds Controlled

terbacil	barnyardgrass, Bermudagrass, bluegrass, chickweed, crabgrass, crowfoot, dogfennel, fireweed, Florida's paintbrush, Florida pusley, foxtail, groundsel, guineagrass, henbit, horsenettle, horse purslane, johnsongrass (seedling), junglerice, knotweed, lambsquarters, mustard, nightshade, panicum, pigweed, purslane, quackgrass, ragweed, sheep sorrel, smartweed, wild geranium, and yellow nutsedge.
terbutol	crabgrass.
triallate	wild oats.
trifluralin	annual bluegrass, barnyardgrass (watergrass), brachiaria, bromegrass, carelessnessweed, carpetweed, cheat, chickweed, crabgrasses, Florida purslane (pusley), foxtails, goosefoot, goosegrass, johnsongrass, junglerice, knotweed, kochia, lambsquarters, pigweeds, (spiny, redroot), purslane, Russian thistle, sandbur, sprangletop, stinging nettle, stinkgrass, Texas panicum, and wild cane (shattercane).
vernolate	annual morningglory, barnyardgrass (watergrass), carpetweed, coffeeweed (sicklepod), crabgrass, Florida pusley, German millet, giant foxtail, goosegrass, green foxtail, johnsongrass seedlings, lambsquarters, pigweed (smooth), purple nutgrass, purslane, redroot pigweed, wild cane, yellow foxtail, and yellow nutgrass.
weeding oils	see oils, aromatic.
2,4-D	many annual and perennial broadleaf weeds.
2,4-DB	Many annual and perennial broadleaf weeds. Canada thistle, cocklebur, curly dock, dead nettle, field bindweed, or wild morningglory, hedge bindweed, jimsonweed, kochia or Mexican fireweed, lambsquarters, narrowleaf plantain, nightshade, pigweed, prickly lettuce, Russian thistle, ragweed, smartweed, stinkweed (fanweed or pennycress), sugar beet, sweet clover, velvetleaf, whitetop, wild buckwheat or corn bindweed, wild mustards, and wild turnip.
2,4,5-T	many annual and perennial broadleaf weeds including brush plants
2,3,6-TBA	bur ragweed, Canada thistle, field bindweed (morning-glory, creeping jenny, or possession vine), leafy spurge, and Russian knapweed.

Agarita (<u>Mahonia trifoliolata</u> Moric.) Fedde)	Blackgum (<u>Nyssa sylvatica</u> Marsh.)
Alder (<u>Alnus spp.</u>)	Bladderwort (<u>Utricularia spp.</u>)
Algae:	Bluegrass (<u>Poa spp.</u>)
Blue-green (many genera)	Bluegrass, Kentucky (<u>Poa</u> <u>pratensis</u> L.)
Filamentous green (many genera)	Boxelder (<u>Acer negundo</u> L.)
(<u>Pithophora spp.</u>)	Brackenfern (<u>Pteridium spp.</u>)
Alligatorweed (<u>Alternanthera</u> <u>philoxeroides</u> (Mart.) Griseb.)	Bramble (<u>Rubus sp.</u>)
Arrowhead (<u>Sagittaria spp.</u>)	Brome, downy (<u>Bromus</u> <u>tectorum</u> L.)
Ash (<u>Fraxinus spp.</u>)	Brome, Scotch (<u>Cytisus</u> <u>scoparius</u> (L.) (Link)
Ash, white (<u>Fraxinus</u> <u>americana</u> L.)	Bromegrass (<u>Bromus spp.</u>)
Aster, woody (<u>Aster parryi</u> A. Gray)	Bromegrass, downy (<u>Bromus</u> <u>tectorum</u> L.)
Baccharis (<u>Baccharis spp.</u>)	Broomsedge (<u>Andropogon</u> <u>virginicus</u> L.)
Barley, wild (<u>Hordeum</u> <u>leporinum</u> Link)	Broomweed, common (<u>Gutierrezia</u> <u>dracunculoides</u> (DC.) Blake)
Barnyardgrass (<u>Echinochloa</u> <u>crusgalli</u> (L.) Beauv.)	Buckbrush (<u>Symphoricarpos</u> <u>spp.</u>)
Bayberry (<u>Myrica pensylvanica</u> Loisel.)	Buckwheat, wild (<u>Polygonum</u> <u>convolvulus</u> L.)
Beakrush (<u>Rhynchospora spp.</u>)	Bulrush (<u>Scirpus spp.</u>)
Bedstraw (<u>Galium spp.</u>)	Burclover (<u>Medicago polymorpha</u> var. <u>vulgaris</u> (Benth.) Shinners)
Bedstraw, smooth (<u>Galium</u> <u>mollugo</u> L.)	Burdock (<u>Arctium spp.</u>)
Beech (<u>Fagus grandifolia</u> Ehrh.)	Burhead (<u>Echinodorus</u> <u>cordifolius</u> (L.) Griseb.)
Bermudagrass (<u>Cynodon</u> <u>dactylon</u> (L.) Pers.)	Buttonbush (<u>Cephalanthus</u> <u>occidentalis</u> L.)
Bindweed (<u>Convolvulus</u> <u>spp.</u>)	Cabomba (<u>Cabomba caroliniana</u> Gray)
Bindweed, field (<u>Convolvulus</u> <u>arvensis</u> L.)	Cactus, cholla (<u>Opuntia spp.</u>)
Birch (<u>Betula spp.</u>)	Canarygrass, reed (<u>Phalaris</u> <u>arundinacea</u> L.)
Bitterweed (<u>Helenium</u> <u>amarum</u> (Raf.) Rock)	Cane, wild (<u>Sorghum bicolor</u> (L.) Moench)

Carpetweed (Mollugo verticillata L.)
 Carrot, wild (Daucus carota L.)
 Catclaw (Schrankia nuttallii (DC.) Standl.)
 Cattail (Typha spp.)
 Ceanothus (Ceanothus spp.)
 Celery, wild (Apium leptophyllum (Pers.) F. Muell.)
 Chara (Chara spp.)
 Cheat (Bromus secalinus L.)
 Cherry (Prunus spp.)
 Chestnut (Castanea spp.)
 Chickweed (Stellaria media (L.) Cyrillo)
 Chicory (Cichorium intybus L.)
 Chinaberry, wild (Melia azedarach L.)
 Chinkapin (Castanea spp.)
 Clover (Trifolium spp.)
 Clover, white (Trifolium repens L.)
 Cockle, corn (Agrostemma githago L.)
 Cockle, cow (Saponaria vaccaria L.)
 Cocklebur (Xanthium spp.)
 Coffeebean. (See Sesbania.)
 Coontail (Ceratophyllum spp.)
 Cottonwood (Populus spp.)
 Crabgrass (Digitaria spp.)
 Crabgrass, hairy (Digitaria villosa (Walt.) Pers.)
 Crabgrass, smooth (Digitaria ischaemum (Schreb.) Muhl.)
 Cress, hoary (Cardaria draba (L.) Desv.)
 Crowfoot, water (Ranunculus spp.)
 Cutgrass (Leersia spp.)
 Daisy (Chrysanthemum spp.)
 Dallisgrass (Paspalum dilatatum Poir.)
 Dandelion (Taraxacum officinale Weber)
 Deathcamas (Zigadenus spp.)
 Dock, curly (Rumex crispus L.)
 Dodder (Cuscuta spp.)
 Dogbane (Apocynum spp.)
 Dogfennel (Eupatorium capillifolium (Lam.) Small)
 Dogwood (Cornus spp.)
 Ducksalad (Heteranthera limosa (Sw.) Willd.)
 Duckweed (Lemna spp.)
 Elbowbush (Forestiera pubescens Nutt.)
 Elderberry (Sambucus spp.)
 Elm (Ulmus spp.)
 Elodea (Elodea spp.)
 Fescue, red (Festuca rubra L.)
 Fescue, tall (Festuca spp.)
 Fimbristylis (Fimbristylis spp.)
 Flatsedge (Cyperus spp.)
 Foxtail, giant (Setaria faberii Herrm.)
 Foxtail, green (Setaria viridis (L.) Beauv.)
 Foxtail, yellow (Setaria glauca (L.) Beauv.)
 Garlic, wild (Allium vineale L.)
 Goldenrod (Solidago spp.)
 Goosegrass (Eleusine indica (L.) Gaertn.)
 Gooseweed (Sphenoclea zeylanica Gaertn.)
 Gorse (Ulex europaeus L.)
 Groundcherry (Physalis spp.)
 Hackberry (Celtis spp.)
 Halogeton (Halogeton glomeratus (M. Bieb.) C. A. Mey.)
 Haw, red (Crataegus spp.)

Henbit (Lamium amplexicaule
 L.)
 Hickory (Carya spp.)
 Honeylocust (Gleditsia
triacanthos L.)
 Horehound (Marrubium
vulgare L.)
 Horsenettle (Solanum
carolinense L.)
 Horsetail rush (Equisetum
 spp.)
 Huisache (Acacia farnesiana
 (L.) Willd.)
 Hydrangea (Hydrangea spp.)
 Indigo, curly (Aeschynomene
virginica (L.) BSP.)
 Ironweed (Vernonia spp.)
 Ivy, ground (Glechoma
hederacea L.)
 Ivy, poison (Rhus
radicans L.)
 Johnsongrass (Sorghum
halepense (L.) Pers.)
 Jointvetch, northern (curly
 indigo) (Aeschynomene
indica L.)
 Knapweed, Russian
 (Centaurea repens L.)
 Knawel (Scleranthus
annuus L.)
 Knotgrass (Paspalum
distichum L.)
 Knotweed (Polygonum spp.)
 Koa haole (Leucaena
Lambsquarters (Chenopodium
 spp.)
 Larkspur, low (Delphinium
nelsonii Greene)
 Larkspur, tall (Delphinium
barbeyi Huth)
 Lettuce, wild (Lactuca spp.)
 Locoweed (Astragalus spp.)

Lotus, American (Nelumbo
lutea (Willd.) Pers.)
 Lupine, silvery (Lupinus
argenteus Pursh)
 Madrone (Arbutus menziessi
 Pursh)
 Manzanita (Arct staphylos
 spp.)
 Maple (Acer spp.)
 Maple, red (Acer rubrum L.)
 Maple, silver (Acer
saccharinum L.)
 Mescalbean (Sophora
secundiflora (Ort.) Lag.)
 Mesquite (Prosopis spp.)
 Mesquite, honey (Prosopis
glandulosa var. glandulosa
 (Torr.) Cockerell)
 Mesquite, velvet (Prosopis
velutina (Woot.))
 Mexicanweed (Caperonia
castaneaefolia (L.) St. Hil.)
 Milkvetch, timberline
 (Astragalus sp.)
 Milkvetch, twogrooved (Astragalus
bisulcatus (Hook.) Gray)
 Morningglory (Ipomoea spp.)
 Mulberry (Morus spp.)
 Mullein (Verbascum spp.)
 Mustard (Brassica spp.)
 Mustard, tumble (Sisymbrium
altissimum L.)
 Naiad (Najas spp.)
 Nightshade (Solanum spp.)
 Nimblewill (Muhlenbergia
schreberi J.F. Gmel.)
 Nutsedge (Cyperus spp.)
 Nutsedge, purple (Cyperus
rotundus L.)
 Nutsedge, yellow (Cyperus
esculentus L.)
 Oak (Quercus spp.)

Oak, blackjack (Quercus marilandica Muenchh.)
 Oak, bur (Quercus macrocarpa Michx.)
 Oak, pin (Quercus palustris Muenchh.)
 Oak, poison (Rhus toxicodendron L.)
 Oak, post (Quercus stellata Wangenb.)
 Oak, red (Quercus rubra L.)
 Oak, shinnery (Quercus havardii Rydb.)
 Oak, water (Quercus nigra L.)
 Oak, white (Quercus alba L.)
 Oak, willow (Quercus phellos L.)
 Oats, wild (Avena fatua L.)
 Onion, wild (Allium canadense L.)
 Orchardgrass (Dactylis glomerata L.)
 Osageorange (Maclura pomifera (Raf.) Schneid.)
 Palmetto (Serenoa repens (Bartr.) Small)
 Paragrass (Panicum purpurascens Raddi)
 Pecan (Carya spp.)
 Pennycress (Thlaspi spp.)
 Pennywort (Hydrocotyle spp.)
umbellata L.)
 Pepperweed (Lepidium spp.)
 Persimmon (Diospyros spp.)
 Phragmites (Phragmites communis Trin.)
 Pickerelweed (Pontederia cordata L.)
 Pigweed (Amaranthus spp.)
 Plantain, buckhorn (Plantago lanceolata L.)
 Pondweed (Potamogeton spp.)
 Pondweed, curlyleaf (Potamogeton crispus L.)
 Poplar (Populus spp.)
 Pricklyash (Zanthoxylum americanum Mill.)
 Pricklypear (Opuntia spp.)
 Princesplume (Polygonum orientale L.)
 Puncturevine (Tribulus terrestris L.)
 Purslane (Portulaca oleracea L.)
 Quackgrass (Agropyron repens (L.) Beauv.)
 Rabbitbrush (Chrysothamnus spp.)
 Ragweed, bur (Franseria discolor Nutt.)
 Ragweed, common (Ambrosia artemisiifolia L.)
 Ragwort, tansy (Senecio jacobaea L.)
 Redbud (Cercis spp.)
 Redstem (Anmania auriculata Willd.)
 Reed, common (Phragmites communis Trin.)
 Reeds (Phragmites spp.)
 Retama (Parkinsonia aculeata L.)
 Rice, red (Oryza sativa L.)
 Rocket, yellow (Barbarea vulgaris R. Br.)
 Rushes (Juncus spp.)
 Sagebrush, big (Artemisia tridentata Nutt.)
 Sagebrush, low (Artemisia arbuscula Nutt.)
 Sagebrush, sand (Artemisia filifolia Torr.)
 Sagittaria, dwarf (Sagittaris subulata (L.) Buchenau)
 Saltcedar (Tamarix pentandra Pall.)
 Sandbur (Cenchrus spp.)
 Sassafras (Sassafras spp.)
 Sedge, Nebraska (Carex nebraskensis Dewey)
 Sedge, ripgut (Carex lacustris Willd.)
 Sedges (Carex spp.)

Sesbania, hemp (Sesbania exaltata (Raf.) Cory)
 Shepherdspurse (Capsella bursa-pastoris (L.) Medic.)
 Signalgrass, broadleaf (Brachiaria platyphylla (Griseb.) Nash)
 Smartweed (Polygonum spp.)
 Sneezeweed (Helenium spp.)
 Sneezeweed, orange (western) (Helenium hoopesii Gray)
 Sorrel, red (Rumex acetosella L.)
 Sowthistle (Sonchus spp.)
 Spatterdock (Nuphar advena (Ait.) Ait. f.)
 Spicebush (Lindera benzoin (L.) Blume)
 Spikerush (Eleocharis spp.)
 Spirea, narrowleaf (Spiraea alba DuRoi)
 Sprangletop (Leptochloa spp.)
 Spurge, leafy (Euphorbia esula L.)
 St. Johnswort (Hypericum perforatum L.)
 Strawberry, wild (Fragaria spp.)
 Sumac (Rhus spp.)
 Sweetgum (Liquidambar styraciflura L.)
 Sycamore (Platanus spp.)
 Tansymustard (Descurainia pinnata (Walt.) Britt.)
 Tarweed (Madia spp.)
 Tasajillo (Opuntia leptocaulis DC.)
 Thistle, Canada (Cirsium arvense (L.) Scop.)
 Thistle, Russian (Salsola kali L. var. tenuifolia Tausch)
 Timothy (Phleum pratense L.)
 Toadflax, Dalmatian (Linaria dalmatica Mill.)
 Tree-of-heaven (Ailanthus altissima (Mill.) Swingle)
 Trumpetvine (Campsis radicans (L.) Seem.)
 Tules (Scirpus spp.). (See Bulrush.)
 Velvetleaf (Abutilon theophrasti Medic.)
 Violet (Viola spp.)
 Walnut (Juglans spp.)
 Waterchestnut (Trapa natans L.)
 Watercress (Nasturtium officinale R. Br.)
 Waterfern (Salvinia spp.)
 Waterhemlock (Cicuta spp.)
 Waterhyacinth (Eichhornia crassipes (Mart.) Solms.)
 Waterhyssop (Bacopa caroliniana (Walt.) Robins.)
 Waterlettuce (Pistia stratiotes L.)
 Waterlily (Nymphaea spp.)
 Waterlily, white (Nymphaea tuberosa Paine)
 Watermilfoil (Myriophyllum spp.)
 Waterplantain (Alisma spp.)
 Waterprimrose (Jussiaea spp.)
 Watershield (Brasenia schreberi Gmel.)
 Waterstargrass (Heteranthera dubia (Jacq.) MacM.)
 Wildrye (Elymus spp.)
 Willow (Salix spp.)
 Woodsorrel (Oxalis spp.)
 Yerba-de-tago (Eclipta alba (L.) Hassk.)
 Yucca (Yucca spp.)

Use Pesticides Safely-Follow the Label